DOES NOT CIRCULATE

SCIENCE

UNIVERSITY OF MICHIGAN
APR 4 1955

1 APRIL 1955

MEDICAL LIBRARY

VOLUME 121 NUMBER 3144

Brain to Body Ratios and the Evolution of Intelligence: *H. J. Jerison* 447

Enrico Fermi: *F. Rasetti* 449

Beryllium-7 Produced by Cosmic Rays: *J. R. Arnold* and *H. A. Al-Salih* 451

News and Notes

National Ferroelectricity Symposium; and Regular Departments 454

Book Reviews

Vitamins: Chemistry, Physiology, Pathology; Zoology; Streams, Lakes, Ponds; Trigonometry; Tables of Integral Transforms; Monomolecular Layers; Das Glas im chemischen Laboratorium; Practical Physiological Chemistry; New Books; and Miscellaneous Publications 462

Technical Papers

Effect of N-1-Naphthyl Phthalamic Acid on Fruit Set of Peaches: *L. J. Edgerton* and *M. B. Hoffman* 467

Brief, Noninjurious Electric Waveform for Stimulation of the Brain: *J. C. Lilly* et al. 468

Use of Haploid and Diploid Embryos of *Habrobracon* in the Study of Cell Poisons: *A. M. Clark* and *W. C. Beiser, Jr.* 469

Incorporation of Radioactive Glycine into Proteins of Frog Oocytes: *N. E. Kemp* 471

Crystal Structure of Rutherfordine, UO_2CO_3: *C. L. Christ, J. R. Clark, H. T. Evans, Jr.* 472

Communications

Big Business and Research: *W. O. Roberts* 473

Influence of Humic Acids on Plant Growth: *P. C. de Kock* 473

Improved Adhesion and Visibility of Cytologic Preparations by Use of the Frosted Glass Slide: *E. S. Dakin* 474

Association Affairs

AAAS Sections Call for Papers for the Atlanta Meeting; New Section Officers; Further Section Reports of the Berkeley Meeting 475

National Association of Boards of Pharmacy 7A

Meetings & Conferences 10A

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

No. 26675 Cenco Moisture Balance, $226.50
No. 26678 disposable pans for solids or liquids,
Pkg. of 25, $2.20 Pkg. of 100, $8.00

Here's the IMPROVED

cenco®
Infrared
MOISTURE BALANCE

FAST, ACCURATE, REPRODUCIBLE MOISTURE DETERMINATIONS

- ★ Reads percent moisture directly
- ★ Dries and weighs simultaneously
- ★ Measures 25 gram or 5 gram samples, either solids or liquids.
- ★ Endorsed by hundreds of users including:

Chemical and Dye Mfrs.	Cosmetic Mfrs.
Candy Mfrs.	Millers
Sugar Refineries	Tobacco Processors
Breweries	Yeast Producers
Dairies	Fertilizer Mfrs.
Pharmaceutical Mfrs.	Stock Feed Mfrs.
Laboratories	Cereal Processors
Paper Mills	Distillers
Rubber Mfrs.	Paint Mfrs.
Leather Tanneries	Cotton Oil Producers

Extremely rapid, accurate and reproducible moisture determinations are made by weighing and drying the sample simultaneously. Drying is by infrared radiation and weighing is by a sensitive null-point torsion balance. Heat rays are so shielded as to have no effect on weighing mechanism.

Write for Bulletin No. 1210B

cenco

The most complete line of scientific instruments and laboratory supplies in the world

R.S.G.

CENTRAL SCIENTIFIC COMPANY
MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.
1718-M IRVING PARK ROAD • CHICAGO 13, ILLINOIS
BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES
CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)
TORONTO MONTREAL VANCOUVER OTTAWA
REFINERY SUPPLY COMPANY — TULSA HOUSTON

Brain to Body Ratios and the Evolution of Intelligence

Harry J. Jerison

Psychology Branch, Aero Medical Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

BRAIN evolution is the obvious correlate of the evolution of intelligence. A gross measure of the evolution of the brain is afforded by a comparison of total brain weights in contemporary species arranged as a phylogenetic series. However, brain weight is correlated with body weight, and comparisons among species must be considered in terms of expected brain weight for any given body weight. This paper (*1*) examines the differential evolution of the mammalian brain with special emphasis on the primates and suggests a specific brain-weight factor correlated with intelligence.

In contemporary mammals the brain weight can be related to the body weight by the function

$$E = kP^{\beta} \qquad (1)$$

in which E is the brain weight and P the body weight. The parameters, k and β, may be determined by fitting a straight line to the log-log scatter plot of brain weight to body weight data; log k is the log E intercept of this line, and β is the slope. Although Eq. 1, the "allometric" size function (*2*), cannot be rationalized at the present time, it provides a satisfactory empirical description of brain and body weight relationships for the mammals as a class. Von Bonin (*3*) has found a correlation of .83 between log E and log P for 115 mammalian measurements and has determined the empirical values of the parameters as $k = .18$, and $\beta = .66$. Using an independent set of 163 measurements from Count's monograph (*4*), I have found a correlation of .92 between log E and log P, with $k = .16$, and $\beta = .67$. When the primates were removed from this computation, the correlation rose to .98. Count's data with fitted regression lines are presented in Fig. 1.

It has been assumed that β in Eq. 1 is a mammalian constant (*3, 5*). In terms of this assumption, k will be the parameter for a family of parallel lines with slope β, and these lines can be drawn through all the points in a log-log plot of brain and body weights. If it is also assumed that the evolution of the brain is described by the steplike displacement of the regression of log P on log E—that is, by increments in the value of k—the value of k for a given mammal can be used as an "index of cephalization"—a numerical statement about the level of evolution of that mammal's brain. This assumption is implicit in the work of Dubois (*5*) and his school and in the work of von Bonin (*3*). The index of cephalization k is, in fact, related to human estimates of intelligence of mammalian orders. Primates (excluding Prosimii) usually have values of k higher than representatives of other orders; ungulates and carnivores have intermediate values, and rodents generally have low values. Difficulties arise, however, when the index is used

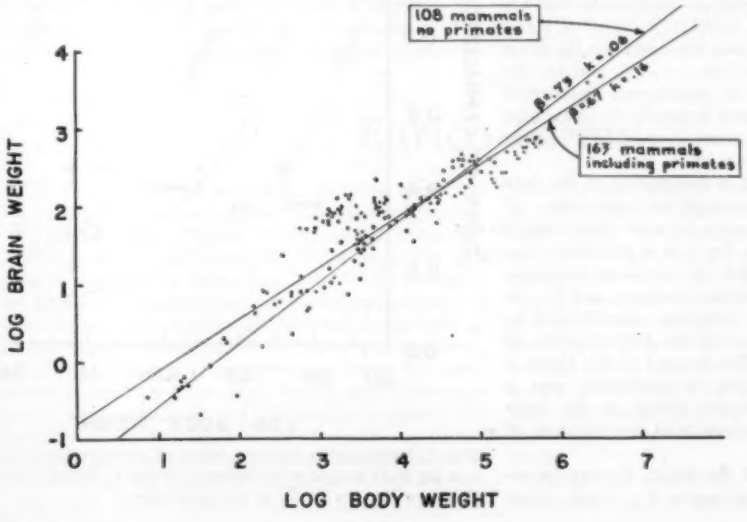


Fig. 1. Log brain weight (grams) as a function of log body weight (grams). The straight lines are graphic representations of Eq. 1 in logarithmic form. Data are from Count (*4*).

Table 1. Index of cephalization (k) and its variability in Anthropoidea. Equation 1 with $\beta = .66$ was used to compute k.

Group*	N	Mean k	σ_k
Man	50	.92	.16
Monkeys†	50	.41	.09
Great apes‡	35	.29	.07

* Groups are ordered in terms of mean k.
† Include *Ateles, Cynopithecus, Macaca, Papio,* and *Presbytis.*
‡ Include *Pongo, Pan,* and *Gorilla.*

within the order Primates. Analyzing data of various authors (*3–7*) for 50 human beings, 35 great apes, and 50 monkeys, the means and standard deviations of k indicated in Table 1 were obtained. Differences between means are all significant at the .001 level of confidence. The perplexing feature in Table 1 is the reversal of the expected order that should put great apes above monkeys in terms of relative brain development. One of the results of the following analysis accounts for this reversal.

Let us, first, examine the assumption that k is a function of level of cerebral evolution. This implies that a group of mammals at the same level of cerebral evolution—that is, of equal intelligence—should have equal values of k. Thus, if we plot k against log P for the primates in Table 1, we should obtain sets of points arrayed about three parallel horizontal lines representing $k = .92$, $k = .41$, and $k = .29$, and within each group the correlation between k and log P should be zero. The actual results of such a plot are given in Fig. 2. (The curves in Fig. 2 will be considered later.) It is immediately obvious that the arrays of points indicate an inverse relationship between k and log P and that the baboons must be differentiated from other monkeys. These suggestions were verified by computing product-moment correlation coefficients for the four arrays of points. The correlations between k and log P are as follows: for man, $r = -.83$; for the great apes, $r = -.82$; for the baboons, $r = -.88$, and for the other monkeys, $r = -.92$. The appropriate description of the subgroups of primates is clearly in terms of a functional relationship between k and log P rather than in terms of mean values of k.

To write a function that is descriptive of the data in Fig. 2, the following assumptions were made. (i) The allometric size relationship between brain weight and body weight stated in Eq. 1 is a primitive relationship that holds true for all mammals including primates. (ii) β is a mammalian constant, and $\beta = .66$. (iii) The evolution of the mammals, characterized by increasing intelligence, involved the differentiation of additional cerebral tissue. The amount of this tissue is correlated with the evolution of intelligence and is unrelated to the body weight, except as the body weight, itself, may be correlated with the evolution of intelligence.

Thus the total weight of the brain, E, may be regarded as composed of two parts, E_v, which varies with the body weight allometrically, and E_c, which is constant for a group achieving a given level of cerebral evolution. In formal terms:

$$E = E_v + E_c \tag{2}$$

and

$$E_v = k' P^{\beta} \tag{3}$$

where log k' represents the log E intercept (see Fig. 1) for primitive mammals—that is, mammals with $E_c = 0$. Equation 1 can then be rewritten as

$$k = \frac{E_c}{P^{\beta}} + k' \tag{4}$$

An appropriate technique for estimating k' enables us to draw a family of curves with E_c as a parameter. The value of k for the opossum, our best contemporary approximation of a primitive mammal (*8*), was used as an estimate of k'; thus $k' = .05$. Equation 4 was then fitted to the data of Fig. 2 by choosing k and log P coordinates in the midst of a cluster of points for each group and computing the corresponding values of E_c. The values of E_c are given on each curve in Fig. 2.

Two results of this approach are of immediate interest. First of all, the problem of the relationships among the mean values of k for the primates disappears. These values, from the present point of view, depend solely on the body weights evolved by con-

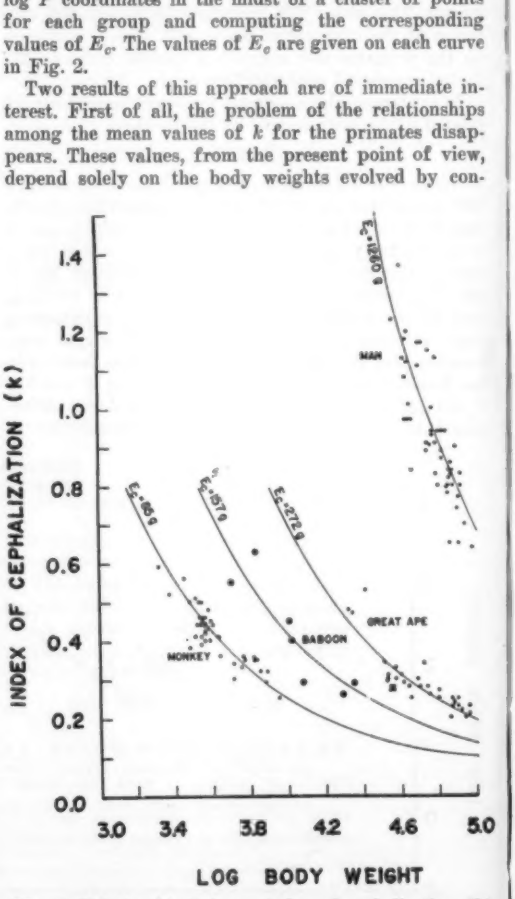


Fig. 2. Relationship between index of cephalization (k) and log body weight of primates in Table 1. Fitted functions are Eq. 4 with E_c as the parameter.

temporary representatives of any given group. If the great apes, for example, had developed the body-weight characteristics of baboons, their predicted range of k would be from .40 to 1.00. Second, and perhaps more important, within the range of values of log P for each of the groups in Fig. 2, Eq. 4 approximates the slopes of the regression lines that could be fitted to the data. Thus, a single rational function has been written, which, when applied to these primates, replaced four empirical equations otherwise necessary to describe the data. It is of some interest that Eq. 4 was written before human data were analyzed, and, as can be seen in Fig. 2, it predicted with some success the slope of the regression of log P on k for man.

Assumption iii, which is fundamental to this analysis, is, of course, a simplification. However, because of the success of Eq. 4 in accounting for our data, it seems reasonable to examine the possibility that this assumption is approximately correct. To do this, it would be necessary to determine precise relationships between number of neurons and brain weight, neuron weight and brain weight, neuron weight and body weight, and similar relationships between weights of other cellular constituents of the brain and the total brain and body weight. But even without such information to lend precision to the present analysis, the suggestion that a large portion of the primate brain weight is independent of the body weight may be important. It indicates, for example, that a specific anatomical correlate for intelligence may be found by pursuing quantitative anatomical studies of the relative development of parts of the brain in monkey, ape, and man as a function of the body weight. Rensch's recent work (*9*) appears especially important in this context.

A more difficult aspect of the third assumption involves the definition and measurement of intelligence in animals. This is largely an unsolved problem, but the present approach suggests that in seeking a solution it would be appropriate to compare species in terms of their values of E_c. In the monkeys, for example, we would expect no differences between *Macaca mulatta* and *M. nemestrinus*, but these forms should be differentiable from the baboons. This analysis can, thus, be considered as contributing to an important problem in comparative psychology, namely, the development of criterions for selecting species for comparisons.

In summary, the general relationship between brain weight and body weight enables us to estimate the expected brain weight for any given body weight. Deviations from the expected brain weight in the primates can be accounted for by assuming a special evolution of the brain in the direction of the development of additional cerebral tissue, the weight of which is independent of the body weight. This approach results in a solution of problems arising from inconsistencies in the "index of cephalization" of primates and suggests directions for further research on the evolution of the brain and intelligence.

References and Notes

1. I wish to thank Virginia L. Senders and Stanley M. Garn for their criticisms and suggestions and Shelley Ehrlich for checking the computations. This research was done independently of my activity as an Air Force Psychologist.
2. J.S. Huxley, *Problems of Relative Growth* (Methuen, London, 1932); E. C. R. Reeve and J. S. Huxley, "Some problems in the study of allometric growth," in *Essays on Growth and Form Presented to D'Arcy Wentworth Thompson*, W. E. L. Clark and P. B. Medawar, Eds. (Clarendon, Oxford, 1945), p. 121.
3. G. v. Bonin, *J. Gen. Psychol.* **16**, 379 (1937).
4. E. W. Count, *Ann. N.Y. Acad. Sci.* **46**, 993 (1947).
5. E. Dubois, *Bull. Soc. Anthrop. Paris*, Ser. 4, **8**, 337 (1897).
6. G. v. Bonin and P. Bailey, *The Neocortex of* Macaca mulatta (Univ. of Illinois Press, Urbana, 1947).
7. G. Crile and D. P. Quiring, *Ohio J. Sci.* **40**, 219 (1940).
8. The choice of the opossum as a representative primitive mammal appears to be especially appropriate for studies on the evolution of the brain, for the endocranial casts of this mammal have been found by Tilly Edinger (*Evolution of the Horse Brain*, Waverly, Baltimore, 1948) to resemble those of the Eocene Equid, *Hyracotherium* (= *Eohippus*).
9. B. Rensch, "Relation between the evolution of central nervous functions and the body size of animals," in (*Evolution as a Process*, J. S. Huxley, A. C. Hardy, and E. B. Ford, Eds., Allen and Unwin, London, 1954).

Enrico Fermi

IF the earmark of genius is ability to reach the summits of creative thought by personal, unsupported effort, Enrico Fermi ranks extremely high among the scientists of our time. He was born in Rome on 26 September 1901. In his childhood he began to manifest an extraordinary interest in mathematics and physics, although there was nothing in the family environment—his father was a railway official—to induce an overpowering desire for these forms of abstract knowledge. During his high-school years Fermi absorbed and thoroughly mastered the contents of an odd assortment of books on higher mathematics, mechanics, and classical theoretical physics, including the theory of relativity.

In 1918 Fermi entered the University of Pisa, where he had little to learn from his teachers, since in most fields his knowledge already equaled or excelled theirs. Thus, he could devote himself fully to the study of the quantum theory, which had developed during and immediately after World War I, chiefly through the work of Planck, Bohr, and Sommerfeld, and which was virtually unknown to Italian physicists. At 21 he received the Ph.D. degree by, strangely enough, presenting an experimental dissertation on x-rays, even though he had already written several important theoretical papers ranging from classical mechanics to statistical mechanics and general relativity.

Fermi then visited the universities of Leiden and Göttingen and met several members of that brilliant

galaxy of theoretical physicists of his own age—he was then in his early 20's—including, among others, Dirac, Heisenberg, and Pauli. These men had had the benefit of the teachings of great masters, such as Bohr, Born, and Sommerfeld; yet Fermi, self-taught, still unknown internationally, did not feel their inferior. In 1926, while teaching theoretical physics at the University of Florence, he published his celebrated paper on the statistical mechanics of particles obeying the Pauli exclusion principle (such as electrons), now collectively designated as *fermions*. This work immediately won him international fame, since Sommerfeld recognized its revolutionary significance for understanding the properties of conduction electrons in metals and many other phenomena.

Fermi's reputation in Germany spread to his own country, where few people had been aware of his exceptional originality as a theoretical physicist. One of these few was Orso Mario Corbino, chairman of the physics department of the University of Rome. Corbino secured for Fermi a chair of theoretical physics in Rome with the possibility of attracting collaborators to found a small school of modern physics. For the first time in more than a century, an Italian school of physics attracted foreign scientists, chiefly young theoreticians. Among the brilliant physicists who came to Rome for extended periods in the early 1930's in order to work with Fermi were Bethe, Bhabha, Bloch, London, Peierls, and Placzek.

In 1933 Fermi published another of his fundamental contributions to theoretical physics, and his first in the nuclear field: "The theory of beta-decay." By this time Fermi had won full recognition in his native country. Since 1928 he had been a member of the Royal Italian Academy, a body created by Mussolini to supervise the cultural life of the nation. Fermi brought into the academy the beneficial influence of his unwavering integrity and high intellectual standards. He was influential in determining new appointments of physics professors in Italian universities exclusively on the basis of scientific merit, regardless of personal influence. He so raised the standards in physics that even now, 17 years after his departure from Italy, a small but very active group is well known internationally for continuing the tradition of modern, high-quality research that he established almost singlehanded.

Fermi's theoretical studies on the structure of the nucleus and the discovery, by Curie and Joliot, of the artificial radioactivity induced by alpha-particle bombardment led him to try to produce similar effects by neutron irradiation. The striking success of this work, Fermi's first major venture in the experimental field, is well known. More than 60 new radioactive nuclei were discovered within a few months in the spring of 1934. In the fall of the same year, the not less startling discovery of the peculiar properties of slow neutrons followed. The results were presented at an international physics meeting in London, and Lord Rutherford himself expressed amazement at the fact that such great experimental achievements were the work, to use his own words, of "a theoretical physicist of the deepest dye." The life of the physicists in Rome during this period (when, as one of Fermi's former students, Emilio Segré, aptly put it, Rome became for a while "the capital of the nuclear world") is vividly portrayed in *Atoms in the Family* by Laura Fermi, whom Fermi had married in 1928. It soon became apparent that these discoveries opened the possibility, at that time thought very remote, of a large-scale release of nuclear energy.

In 1938 Fermi was awarded the Nobel prize for these experimental discoveries. There is no doubt that, had he never done any experimental work, his theoretical achievements would have made him well worthy of that distinction. At the same time, the increasing Fascist control on national life, and especially the racial persecution following the Axis alliance, made him look longingly to the United States, where universities enjoyed freedom from political pressure. After visiting Stockholm to receive the Nobel prize, he sailed directly to the United States with his wife and two children, having accepted a professorship at Columbia University.

As soon as the discovery of nuclear fission by Hahn and Strassmann made the practical utilization of nuclear energy seem much less remote than before, Fermi undertook preliminary experiments on neutron multiplication and moderation, aiming at the goal of a self-sustaining chain reaction. This work was soon covered by the blanket of military secrecy, and most people did not realize, until the publication of the Smyth Report at the end of the World War II, the historic event that had taken place in Chicago on 2 December 1942. There, after building a uranium-graphite pile, Fermi had achieved the first large-scale release of nuclear energy and opened its immense military, economic, social, and political consequences. Fermi also played an important part in subsequent developments at Los Alamos. After the war, he resumed peacetime research in Chicago, first on neutron optics and later, with the construction of the large synchrocyclotron, in the still mysterious and fascinating domain of the high-energy interactions between nucleons and the related new elementary particles.

It is not possible to give here even a remote idea of the vastness and depth of Fermi's work in almost all branches of physics, from classical mechanics to relativity and statistical mechanics, from spectroscopy to quantum electrodynamics, and from nuclear physics to cosmic rays, to mention but some of the fields of physics on which he left the indelible imprint of his genius. If, in theoretical physics, he was second to none, as a combination of a theoretician and an experimenter he was unique. For this reason, among others, he enjoyed unequaled authority and prestige. Other qualities that won him universal admiration were an extraordinary degree of personal disinterestedness and his excellence as a teacher. For Fermi, the advancement of science and the loyalty to institutions devoted to this purpose came first; personal advantages mattered nothing. Hence, his opinions, not only

on purely scientific matters, but also on questions more susceptible to distortion by human passions, always carried great weight.

Fermi was also an incomparable teacher, from the time, in his college years, that he introduced me and a few other fellow-students to the first mysteries of theoretical physics. He was gifted with great clarity and orderliness of exposition; many times a question asked by one of his students or colleagues was answered by a masterful, exhaustive, improvised lecture on the subject which, if taken down word for word, could have been sent almost unchanged to the editor of a scientific journal. Physicists familiar with his work well know the outstanding clarity and thoroughness of all his publications; for example, the treatment given in his historical papers on Fermi statistics and the theory of beta-decay is so perfect that hardly a word need be changed or added even today, more than a score of years after those articles were written. Also well known for easily readable treatments of difficult subjects are his 1932 article on the quantum theory of radiation and his book, *Elementary Particles*, which records the contents of the 1950 Silliman lectures.

Fermi was probably the most sought-after lecturer in physics of the last two decades. Universities, academies, and other scientific institutions all over the world vied in securing his participation in lectures, meetings, and symposiums, certain that his presence would stimulate creative discussion and often lead to important advances. During the summer of 1954 Fermi lectured, for the last time, at the schools of advanced physics at Les Houches in France and Varenna in Italy. His mind was as brilliant as ever, but his body was beginning to suffer from the attacks of a fatal disease. Most of his colleagues hardly suspected the gravity of his illness, and they were greatly shocked, when the man, who, more than any other single individual, fathered the advent of the atomic age, passed away in Chicago on 28 November 1954.

FRANCO RASETTI
Department of Physics, Johns Hopkins University

Beryllium-7 Produced by Cosmic Rays

James R. Arnold and H. Ali Al-Salih
Institute for Nuclear Studies, University of Chicago, Chicago, Illinois

IN his classic paper of 1946, W. F. Libby (*1*) predicted the existence of cosmic-ray-induced radioactivities in the atmosphere, in particular C^{14}, with a half-life of 5600 yr. and tritium, with a half-life of 12.4 yr. Both nuclides have now been discovered and used to study a wide variety of processes having time-scales comparable to their respective half-lives (*2*). Carbon-14 is made by low-energy neutron capture in nitrogen, whereas tritium results chiefly from high-energy interactions, or "stars."

Two other nuclides may be expected to result from these high-energy interactions in nitrogen and oxygen. These are Be^7, with a half-life of 53 days, and Be^{10}, with a half-life of 2.5×10^6 yr. Because of their well-spaced half-lives these species should be of geochemical interest. This paper (*3*) reports the discovery of cosmic-ray produced Be^7.

Our picture of the history of this nuclide is as follows. The peak of the star production occurs about 15 km above the surface (*4*). Beryllium formed at this height will form BeO, or just possibly $Be(OH)_2$. The nonvolatile molecule will diffuse in the atmosphere until it encounters a dust particle, to which it will adhere. Its further history is that of the upper atmosphere dust.

It appeared probable that the great majority of upper atmosphere dust particles ultimately form cloud nuclei, which are carried down in rain, or are otherwise washed out by rain. Rain water then seemed a likely location for Be^7. A series of rain-water samples taken at Chicago and at Lafayette, Indiana, were analyzed for this nuclide.

In each case a sample of rain water of 5 to 50 gal was collected from a roof (it therefore included some "between-rains" dust), 1 to 2 ml of Be^{++} carrier per gallon (5 mg BeO/ml) was added, with sufficient nitric acid to bring the *p*H to about 3. After thorough agitation, the solution was brought to *p*H 9 with ammonia, precipitating $Be(OH)_2$ along with substantial quantities of $Fe(OH)_3$ and other species present in rain water in this industrial area or originating in the cans used for collection in some cases. This flocculent precipitate served as a general carrier. After the sample had been allowed to stand for 30 min or more, it was filtered, and the clear filtrate was discarded.

An early experiment showed that all the activity remained in the precipitate at this point. The precipitate was ashed and fused with $KHSO_4$. After the supernate was leached and centrifuged, it was scavenged with CuS and then was made strongly basic to precipitate $Fe(OH)_3$ and other group-III hydroxides. The supernate was acidified and then made basic with NH_4OH, yielding a precipitate containing the $Be(OH)_2$. This was then put through an acetate-chloroform cycle following McMillan (*5*) and finally was precipitated as $Be(OH)_2$ and ashed to BeO.

The yields for this procedure were erratic but improved with experience; they range from 20 to 80 percent in the samples reported. Radiochemical purity

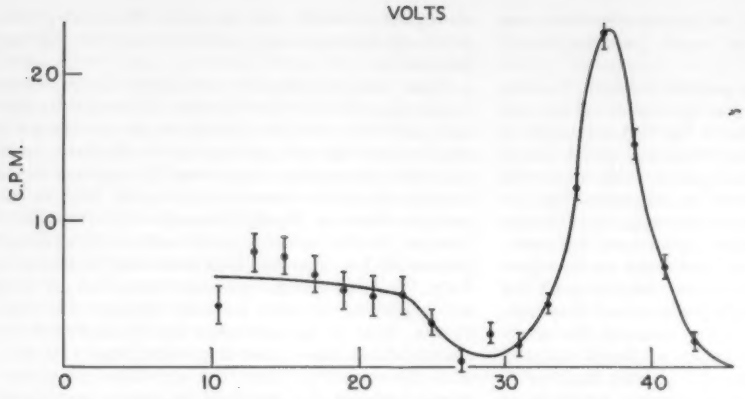


Fig. 1. Spectrum of composite sample, using a 2-in. well crystal.

was tested by counting the samples in an end-window beta counter. No activity was observed. The samples were counted on our low-level scintillation spectrometer, using a 1-in. NaI (Tl) crystal, at a setting admitting the full photopeak of Be^7.

The nature of the activity observed was verified in three ways. First, repeated cycles of the highly specific acetate-chloroform procedure showed constant specific activity (which would be expected, since this procedure has almost no interferences). Second, the scintillation spectrum of the activity shows the characteristic photopeak of a pure gamma emitter, with energy 472 ± 10 kev. Figure 1 shows the spectrum of a composite sample, taken in a 2-in. well crystal. Finally, the half-life checks the literature value; Fig. 2 shows the decay curve of sample RS, and Fig. 3 that of a composite sample.

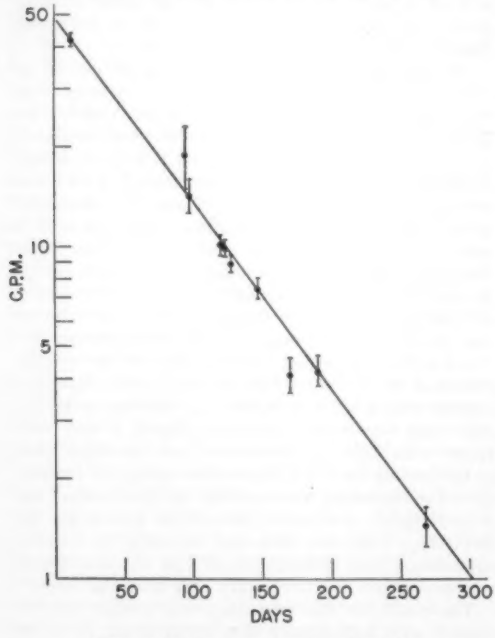


Fig. 2. Decay curve of sample R.S.

The results for a series of rain and snow samples are shown in Table 1. The wide variations in successive rains are obvious and parallel Libby's earlier tritium results. In the cases where rain from the same storm was taken at both locations (RZ and PA, SE and PD), the agreement is satisfactory. More important for our purpose is the absence of a systematic drift with time. Seven samples taken before 13 March 1954 average 2.12 count/min gal, while 15 taken on or after that date average 2.00. Taken together with the 53-day half-life, the absence of an increase during and after the American nuclear weapons test of last spring substantially demonstrates the natural origin of this nuclide.

We may attempt to estimate the rate of production Q of Be^7 from the foregoing data. First, the average value of 2.04 counts/min gal must be converted to absolute units. Using McGowan's (*6*) values for a source-to-crystal distance of 3 mm, we get a total counting efficiency of 0.19 and the fraction in the photopeak 0.47. Since only 11 percent of the decays produce the 479-kev gamma ray, the over-all counting efficiency is 0.0099, and the absolute assay is 54 decays/min lit, or 6×10^6 atoms/lit. In units equivalent to Libby's T units this is 0.09.

Assuming 1 m of annual rainfall, each square centimeter of earth's surface in the Chicago area receives 6×10^5 atoms/yr, or 0.019 atoms/sec. In order to translate this into a production rate, some estimate must be made of the time-scales of a number of atmospheric processes: (i) the vertical mixing in the lower stratosphere where most of the production occurs; (ii) vertical mixing in the troposphere, from the tropopause down to cloud level or below; (iii) north-south mixing (because of the great difference between high- and low-latitude production rates); (iv) east-west circulation, which plays a role because of the differences between geographic and magnetic latitude; and (v) frequency of substantial rainfall.

Of course none of these processes occur in a systematic pattern, either in time or space, but gross averages may be useful. The fluctuations seem ample to account for the observed variations. This is especially true of the north-south mixing, since Chicago is almost at the southern edge of the high-latitude plateau of the cosmic-ray flux.

Rough relaxation times might be guessed as follows:

Process	Time scale
Vertical mixing, stratosphere	
Temperate zone	60 to 180 days
Tropic zone	30 days
Vertical mixing, troposphere	15 days
North-south mixing	
Stratosphere	100 days
Troposphere	10 days
East-west mixing, troposphere	5 days
Frequency of substantial rainfall	
Temperate zone	15 days
Tropic zone	15 days

All these numbers, except the one for the east-west mixing process, are comparable to the 53-day half-life. This makes calculation difficult, but we can still make an attempt. First, if all processes were assumed fast, the world-wide Q would be the Chicago rate of 0.019 atoms/sec cm^2. If we assume that the newly formed Be atoms spend 80 days in descending to cloud level, and that the north-south and east-west mixing lower the concentration of Be^7 at Chicago by 30 percent (which is half the effect of complete north-south mixing) before rainfall brings it down 10 days later, we get a value for the world-wide Q of $0.019 \times 2^{90/53} \times 0.4/0.7 = 0.035$ atoms/sec cm^2.

The data on the primary cosmic-ray flux on which the effect of north-south mixing is calculated are those of Winckler and Stix (*7*) and Simpson (*8*). These give 1 per square centimeter per second for the primary flux at high latitude, from which we compute a value of 0.4 per square centimeter per second for the world-wide average.

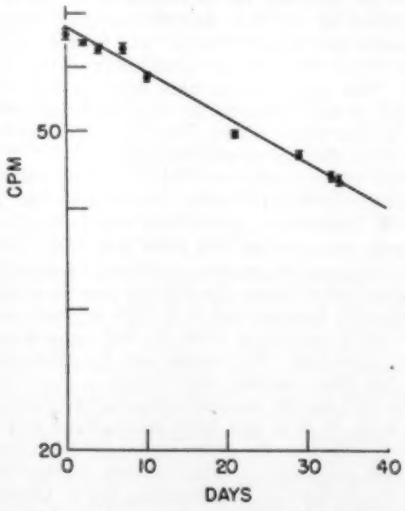


Fig. 3. Decay curve of composite sample.

Table 1. Cosmic-ray-produced Be^7 in some rain and snow samples.

Sample	Place collected	Date	No. of gallons	(counts/min gal)$_c$
RS	Chicago	10–26–53	30	2.30 ± 0.10
RX		12– 2–53	15	1.42 ± 0.22
RZ		1–20–54	30	2.81 ± 0.34
SA		1–26–54	10	3.26 ± 0.26
SB		2–28–54	10	0.70 ± 0.16
SC		3– 3–54	9	0.56 ± 0.10
SD		3–13–54	10	1.15 ± 0.30
SE		3–18–54	5	1.27 ± 0.35
SF		3–24–54	10	1.67 ± 0.11
SG		3–29–54	6	1.65 ± 0.18
SK		4–21–54	5	5.00 ± 1.12
SL		4–22–54	5	2.75 ± 0.40
SN		5– 4–54	5	1.37 ± 0.33
SO		5–11–54	5	5.40 ± 0.45
ST		6–17–54	5	3.52 ± 0.14
SU		7– 3–54	17	1.20 ± 0.04
SV		7– 6–54	10	2.44 ± 0.07
PA	Lafayette	1–20–54	50	3.76 ± 0.24
PB		3–20–54	15	0.94 ± 0.09
PD		3–19–54	15	0.88 ± 0.13
PE		4–17–54	15	0.35 ± 0.06
PF		4–27–54	10	0.48 ± 0.07

The expected value of Q cannot be computed accurately on the basis of presently known cross sections, the greatest uncertainty being in the number of Be^7 atoms produced by secondaries. The best estimates, using cross sections of Baker and Hudis (*9*) and estimating production by secondaries from the neutron data (*4*), give values that range between extremes of 0.015 and 0.06. This lends support to our proposed mechanism of formation and distribution of Be^7 in the atmosphere.

Interestingly enough Be^7 is the easiest of all the cosmic-ray-produced nuclides to detect, despite its comparatively low production rate, because it occurs substantially carrier-free. The possibility of using this nuclide to study the afore-mentioned atmospheric processes is apparent.

References and Notes

1. W. F. Libby, *Phys. Rev.* **69**, 671 (1946).
2. ———, *Radiocarbon Dating* (Univ. of Chicago Press, Chicago, 1952); S. Kaufman and W. F. Libby, *Phys. Rev.* **93**, 1337 (1954).

3. We wish to express our thanks to W. H. Johnston and his students at Purdue University for gathering and partially processing the Lafayette samples. We are indebted to Luis Marquez, Anthony Turkevich, Gerhart Friedlander, and W. F. Libby for helpful discussions, and particularly to Herbert Riehl, who was of great assistance on meteorological questions. Trans World Airlines furnished assistance in some preliminary experiments. The Office of Ordnance Research contributed generous support.

4. L. C. Yuan, *Phys. Rev.* **81**, 175 (1951).
5. E. M. McMillan, *ibid.* **72**, 591 (1947).
6. F. K. McGowan, *ibid.* **93**, 163 (1954); also unpublished tables.
7. J. R. Winckler *et al.*, *ibid.* **79**, 656 (1950).
8. J. A. Simpson, Jr., private communication.
9. E. Baker and J. Hudis, private communication (through G. Friedlander).

News and Notes

National Ferroelectricity Symposium

On 26 January 1955 a 1-day symposium on ferroelectricity was held at the Signal Corps Engineering Laboratory, Fort Monmouth, N.J., under the joint sponsorship of the Signal Corps and the Ceramic Association of New Jersey. The symposium was opened by Brigadier General Francis F. Uhrhane, (director, Signal Corps Engineering Laboratories). The first paper, "Problems of manufacturing to meet specifications for titanate ceramics" was delivered by Rolland R. Roup (Globe Union, Inc., Milwaukee, Wis.). The effect on dielectric constant and piezoelectric constant of firing ceramic barium titanate in different type kilns and the beneficial effect of water vapor atmospheres were shown.

Werner Kaenzig (University of Illinois) gave a paper on the "Surface properties of very small ferroelectric particles." Experimental results from x-ray diffraction measurements of c/a ratios on colloidal barium titanate with particle size of the order of 1000 A, show no curie point up to 800°C. For small ferroelectric particles a surface layer of space charge may build up as high as 10^5 v/cm. Ray Pepinsky (Pennsylvania State University) discussed "Ferroelectric and antiferroelectric phase transitions." Among the many structures discussed was that of ferroelectric lead titanate in which the titanium and lead atoms are both displaced in the same direction with respect to the fixed oxygens, namely, 0.29 A and 0.46 A.

W. P. Mason (Bell Telephone Laboratories) discussed "Ferroelectrics and the dielectric amplifier." The dielectric amplifier and its frequency limitations and the effect on the titanates of various additions to arrest the aging effect of the piezoelectric constant were ably shown.

W. J. Merz (Bell Telephone Laboratories) gave a talk on "Static and dynamic properties of the ferroelectric domains in $BaTiO_3$ single crystals." He demonstrated parallel and antiparallel domains with polarized light and actual crystals of barium titanate.

E. T. Jaynes (Stanford University) talked on "Electro-optical and paramagnetic experiments with barium titanate crystals." In addition to the electro-optical effect described with barium titanate, resonance experiments showed a complex absorption spectrum as a function of magnetic field at 9000 mc with the g-factor going down to 2, as expected, above the curie point.

Following the papers a panel discussion was held with the afore-mentioned speakers and Hans Jaffe (Brush Electronics Co., Cleveland) and E. Wainer (Horizons, Inc., Cleveland) participating.

A. P. deBretteville (Chemical Physics Branch, Signal Corps) was chairman and J. H. Koenig (Rutgers University) was cochairman.

V. F. PAYNE

400 Atlantic Avenue, Long Branch, New Jersey

Science News

In a speech delivered in Montreal at the annual Wildlife Conference of North America, which had as its theme "The use of natural resources—a continental challenge," William Vogt, national director of the Planned Parenthood Federation of America, predicted that the **population of the United States would double** in approximately 40 yr and that this country would exhaust its natural resources unless the population rise were checked. He said that the United States probably has more natural wealth than any other part of the world, yet the cost to the nation of providing water, food, and social services for 164,000,000 more persons in such a relatively short time would place a heavy burden on the people.

> We could probably get by, but only at two certain and enormous costs—a greatly lowered standard of living and an appalling increase in Government controls over many phases of our lives.

Vogt said the United States was consuming 10 percent more raw materials than it produced, whereas 50 yr ago 15 percent more raw materials were produced than consumed. With regard to the world's unrenewable resources, it has been calculated that this country already utilizes 50 percent of these, and by 1980, if the present rate continues, will be consuming 83 percent. Vogt also warned that space is another "resource" that is being rapidly depleted in North America and that it, like water, is not something for which a substitute can be found.

The **Indian Agricultural Research Institute,** New Delhi, popularly known as the Pusa Institute, is 50 yr old this year; the event is being celebrated 1–4 Apr. The institute, the establishment of which was facilitated by a gift of £30,000 from the American philanthropist Henry Phipps, was located at Pusa, Bihar, from 1905 until the great Bihar earthquake of 1934. This caused irreparable damage, and it was decided to move the institute to a 1000-acre reservation in New Delhi, where new laboratories and buildings were officially opened in 1936.

There are at present six major divisions within the institute: agronomy; botany; soil science and agricultural chemistry; agricultural engineering; entomology; and mycology and plant pathology. Each of these divisions has separate buildings, an experimental area, and a library. In addition there is a central library that receives more than 1000 different periodicals and is considered to be the best agricultural library in the East. The institute also has three substations, at Pusa, Karnal, and Simla.

Not only has the institute accomplished much valuable work in crop and herd improvement and pest control, but over the years it has built up several valuable collections: varieties of crop plants, insects, and the Herbarium Cryptogamae Indiae Orientalis.

One of the important activities of the institute is

the provision of postgraduate training to students and to deputies from the various state agricultural departments. The students have the choice of nearly 20 different 2-yr courses, for each of which there is a carefully planned syllabus. Hundreds of men trained at the institute now occupy important positions throughout the country. Students from neighboring Asian countries are also enrolling in these courses. For the past 5 yr the Central College of Agriculture of Delhi University, has also been located in the institute.

Recently the institute has undertaken agricultural extension work in Delhi villages. It also cooperates with the Food and Agriculture Organization of United Nations in the maintenance and description of genetic stocks of wheat, and with the U.S. Technical Cooperation Mission in conducting fertilizer tests. At present the institute is on the threshold of further expansion: A new hostel that can accommodate 100 more students has been constructed, and a laboratory for undertaking research on trace elements has been completed. Soon a cartographic laboratory will also start to function; and in addition, existing laboratories are being provided with more greenhouses and new equipment.

A **miniature digital computer** that can operate in planes flying at supersonic speed has been developed for the U.S. Air Force by Bell Telephone Laboratories. J. H. Felker, an electrical engineer, directed the work. The instrument eliminates vacuum tube failure and heat, jet aircraft's greatest electronic problems, by the use of transistors, nearly 800 of them, instead of vacuum tubes. This is believed to be the first all-transistor computer designed for aircraft.

The new computer, known as TRADIC (TRansistor-DIgital-Computer), requires less than 100 w to operate. This is one-twentieth of the power needed by vacuum tube computers designed for the same function. Early computers used as many as 18,000 vacuum tubes and frequently required thousands of watts to operate.

The new instrument contains, in addition to transistors, nearly 11,000 germanium diodes. Solid, like transistors, they are capable of operating thousands of times faster than their mechanical counterparts. When design work has been completed, the computer will probably occupy less than 3 ft^3 of the critical space in modern military aircraft.

Successful use of a **new synthetic hormone** to treat Addison's disease, and as a diagnostic aid in determining the degree of adrenal gland function in other diseases, is described in the 17 Mar. issue of the *New England Journal of Medicine* by a research team from the Harvard Medical School and Peter Bent Brigham Hospital. The group is headed by George W. Thorn and includes Alan Goldfien, John C. Laidlow, Najib Abu Haydar, and Albert E. Renold. These men have found by clinical trial with human patients that a derivative of hydrocortisone, known as fluorohydrocortisone, greatly intensifies and lengthens the metabolic and therapeutic effects of the parent drug and prolongs the duration of action in treatment of Addison's disease. Fluorohydrocortisone is obtained by inserting a fluorine atom at the 9-Alpha position of hydrocortisone. The synthesis was made by Josef Fried and Emily F. Sabo of the Squibb Institute.

Discovery that cortisone was one of the essential secretions of the adrenal cortex and that it restored those afflicted with Addison's disease to lives of normal activity came in 1948, 13 yr after the first granules of the drug had been isolated by Edward C. Kendall of the Mayo Foundation Biochemical Laboratory. Earlier the disease had normally resulted in death within a period ranging from a few days or weeks to as long as 3 yr.

At present the new compound is available for experimental purposes only. Thorn says of the drug

> "Its great theoretical interest is that chemists have been able to synthesize an adrenal hormone which is 10 to 50 times more active than that provided by the body itself."

A recent issue of the 27-yr-old ***Hebrew Medical Journal,*** which is under the editorship of Moses Einhorn of New York, is dedicated to the 750th anniversary of the death of Maimonides, the renowned Jewish medieval physician and philosopher. A series of articles in this issue deal with his life and outstanding contributions in the fields of medicine and philosophy. A biographical sketch on Maimonides is contributed by the editor, who cites some of Maimonides' maxims on what makes a good doctor.

> Besides the power to heal, a doctor must possess an independent mind. . . . Medicine is necessary to man, not only when he is sick, but also when he is healthy. . . . A doctor must be a whole man, observant, cautious, and attentive to each patient on the presumption that his case is individual and special.

Other articles on Maimonides deal with "The influence of religion and philosophy upon Maimonides as physician"; "Maimonides' opposition to occultism"; and "The impact of Maimonides upon medieval writers in the field of medicine." The journal is written in Hebrew with English summaries.

A recent issue of the *Journal of the American Medical Association* describes good results in **treating typhoid fever with a new antibiotic** drug called synnematin B, which comes from the organism Tilachlidium. It was given to 16 children of ages from 2½ to 11 yr at the Hospital Infantil in Mexico City. Regardless of the day of sickness on which treatment with the drug was started, the temperature returned to normal, the toxic state was relieved, appetite increased, and mental alertness improved in from 2 to 6 days. The patients all recovered and none had any intestinal bleeding or perforations.

The results of this trial of synnematin B are reported by Lazaro Benavides V. of the Hospital Infantil; Birger H. Olson and Stephen H. Holt of the Michigan Department of Health Laboratories, Lan-

sing, Mich.; and Gerardo Varela of the Instituto de Salubridad y Enfermadades Tropicales, Mexico City. Olson and Holt had previously shown that synnematin B was not toxic for human beings and that it was active against a wide variety of Salmonella, the germ family to which the typhoid fever germs belong. Synnematin was discovered by R. Gottshall and some colleagues at the Michigan State Department of Health and later separated into synnematin A and synnematin B by Olson and his coworkers.

A group of approximately 30 investigators and clinicians who are specialists in the development of artificial kidneys, artificial heart-lung machines, and similar biomechanical equipment have organized a society, the **American Society for Artificial Internal Organs**, for the purpose of exchanging information and of stimulating developments in this field. Information may be obtained from the acting secretary, Dr. Peter F. Salisbury, Institute for Medical Research, Cedars of Lebanon Hospital, 4751 Fountain, Los Angeles 29, Calif.

Ten insurance executives have been briefed by the Atomic Energy Commission on the pertinent aspects of the national atomic energy program. In order that the civilian use of atomic energy may be expedited, these executives were selected to consider problems confronting the insurance industry in providing **insurance coverage for private reactor operations.** It is intended that these men will issue an unclassified report on the results of their studies for use by the insurance industry.

The United Nations Educational, Scientific and Cultural Organization has reported that at a recent meeting in New Delhi, India, Soviet scientists described the use of **solar energy to operate small factories.** The scientists said that colleagues in a laboratory in Tashkent, near Afghanistan, had developed curved mirror reflectors nearly 40 ft in diameter that are used in factories to help produce as much as 100 lb of high-pressure steam an hour.

It is reported that canneries, refrigerating plants, and water distilling factories are being operated on solar energy, and that solar-energy heaters are being used to make fresh water from salt water. One plant is said to produce 250 gal of distilled water a day.

Scientists in the News

Silas B. Hays, a major general in the Army Medical Corps, has been nominated by President Eisenhower to be the Surgeon General of the Army, effective 1 June. Hays, who has been Deputy Surgeon General for the past 4 yr, succeeds George E. Armstrong, major general, who is scheduled to retire from active duty.

Four scientists of the U.S. Navy Bureau of Ships and the Naval Research Laboratory, and one now employed by the Atomic Energy Commission, recently received awards totalling $2400 for their work in developing the dosimeter, an inexpensive device for measuring radiation doses [*Science*, **118**, 184 (14 Aug. 1953)]. Five other scientists who worked on the project and who are not now in the Washington, D.C., area, also received awards.

Those honored are **James H. Schulman,** NRL; **R. J. Ginther,** NRL; **C. R. Horner,** AEC; **Clifford C. Klick,** NRL; **Samuel C. Rainey,** Bureau of Ships; **J. Cryden,** Los Angeles, Calif.; **L. W. Evans,** Seneca Falls, N.Y.; **A. Lovoff,** Western Springs, Ill.; **W. F. Gray,** Eglin Air Force Base, Fla.; **Raymond Alger,** U.S. Navy Radiological Defense Laboratory, San Francisco, Calif.

Sidney Burwell, research professor of clinical medicine at the Harvard Medical School since 1935, has been appointed as Harvard's first Samuel A. Levine professor of medicine. The new chair was established in November, 1954, by Charles E. Merrill, New York investment banker, in honor of Levine, his friend and physician and a well-known clinical professor of medicine at Harvard.

Frederic de Hoffmann, who has been connected with the Los Alamos Scientific Laboratory since 1944, will join the Convair Division of the General Dynamics Corp., San Diego, Calif., on 15 Apr. as assistant vice president for nuclear planning. He will guide the investigation of new applications of nuclear energy, both military and industrial, and head research on current nuclear projects. De Hoffmann is particularly noted for his work on the development of the atomic and hydrogen bombs and for his studies in nuclear reactor theory and high-energy nuclear physics. In 1954 he was appointed a consultant to the Joint Congressional Committee on Atomic Energy, acting as a member of a special panel to study atomic energy and its relationship to continental defense.

Roy B. Snapp, formerly special assistant to the chairman of the U.S. Atomic Energy Commission, has been awarded the commission's Certificate of Distinguished Service "In recognition of outstanding performance of duty with the United States Atomic Energy Commission and its predecessor, the Manhattan Engineer District, Corps of Engineers, U.S. Army, from April 30, 1946 to March 1, 1955." Snapp left the AEC on 1 Mar. to enter the private practice of law in Washington.

William Albert Zisman, an authority in the field of lubrication and head of the surface chemistry branch of the Naval Research Laboratory, Washington, D.C., has received the 1955 Hillebrand award of the American Chemical Society's Washington section. **Victor K. La Mer,** professor of chemistry at Columbia University, gave the principal address at the award dinner. He was selected as speaker by the award winner in accordance with the Hillebrand award tradition. His topic was the "Rate of evaporation of water through fatty acid monolayers."

Zisman directed the development of a lubrication system for aircraft machine guns that assured com-

pletely reliable functioning in the extreme cold during the recent Korean conflict. He received the Navy's Distinguished Civilian Service award for this and other outstanding research in lubrication. His investigations at NRL led to the synthesis during World War II of new and important liquid lubricants and new classes of synthetic greases now widely used in the aviation industry at extremely high and low operating temperatures.

Thomas M. Shaw, former senior research physicist at the Western Regional Research Laboratory of the U.S. Department of Agriculture, has joined Southwest Research Institute, San Antonio, Tex., in the same capacity. He will be responsible for research on applications of radio-frequency spectroscopy and microwave spectroscopy to chemical problems.

Sidney Mittler, research biologist at Armour Research Foundation of Illinois Institute of Technology, is the recipient of the award of scientific merit presented by the foundation's chemistry and chemical engineering research department for "outstanding individual scientific accomplishment." He was honored for his work in studying trace elements in nutrition.

Richard S. Caldecott, formerly a radiobiologist at the Brookhaven National Laboratory, has joined the staff of the agronomy and plant genetics department, University of Minnesota, under the auspices of the U.S. Department of Agriculture. He will continue basic studies with ionizing radiations that are supported by an Atomic Energy Commission contract.

Barry G. King, research executive in the medical division of the Civil Aeronautics Administration and associate professor of physiology at Ohio State University, has received the Department of Commerce exceptional service award, a gold medal, for aviation medical research and aviation medical training programs.

A portrait of **T. P. Nash, Jr.,** dean of the School of Biological Sciences at the University of Tennessee Medical Units, will be presented to the university by former students and associates of Nash, who has been connected with the university for almost 40 yr. The portrait will be hung in the new Chemistry-Physiology Building.

Leon M. Dorfman, a former research associate at Knolls Atomic Power Laboratory, is now a research associate in the electron physics department of the General Electric Research Laboratory, Schenectady, N.Y.

Harold C. Urey, Ryerson distinguished service professor of chemistry at the Institute of Nuclear Studies, University of Chicago, and winner of the Nobel prize in chemistry in 1934, has received Dickinson College's Priestley memorial award for 1955. The award, a Wedgwood medallion and $1000, is conferred annually upon a scientist for research, discovery, or production benefiting mankind.

Vincent du Vigneaud, professor and chairman of the department of biochemistry of Cornell University Medical College, New York, has been selected as the recipient of the $5000 Passano Foundation award for 1955. On 8 June, during the week of the American Medical Association convention in Atlantic City, a reception dinner will be held at the Traymore Hotel to honor du Vigneaud. He is being honored for his investigation of the chemical and physiologic nature of the hormones of the posterior portion of the pituitary gland. This culminated in the identification and synthesis of oxytocin and vasopressin [*Science* **118**, 543 (6 Nov. 1953)].

The University of Virginia has announced the appointment of **W. Ralph Singleton,** senior geneticist of the Brookhaven National Laboratory, as Miller professor of biology and director of the university's Blandy Experimental Farm; he succeeds **Orland E. White,** whose retirement becomes effective this June. Singleton will lead a program of graduate research in radiation genetics and horticulture that will emphasize the development of plant strains resistant to disease and drought. Like White, Singleton completed work for his doctorate at the Bussey Institution of Harvard University under the late Edward M. East.

Alfred Traverse, formerly coal technologist at the Charles R. Robertson Lignite Research Laboratory, U.S. Bureau of Mines, Grand Forks, N. Dak., has been transferred to the coal technology branch of the Denver Experiment Station, U.S. Bureau of Mines, where he will be in charge of a newly organized fuels microscopy laboratory at the Denver Federal Center. The research program of this laboratory will be concentrated primarily on petrography of coals of the Western United States.

Filadelfo Panlilio, at present associated with the University of the Philippines at Quezon City, will join the Union College (Schenectady, N.Y.) faculty this fall as an associate professor of mechanical engineering. Panlilio was a member of the faculty at the University of Michigan from 1944 until 1948, when he returned to Quezon City.

The University of Rochester has announced the appointment of **Edwin O. Wiig** as chairman of its department of chemistry to succeed **W. Albert Noyes, Jr.,** who has headed the department since 1939. Wiig has been a member of the Rochester faculty since 1932 and has been a full professor since 1945. Noyes has asked to be relieved of the chairmanship in order to devote more time to his research in photochemistry and to his duties as dean of the graduate school. He will continue as Charles Frederick Houghton professor of chemistry.

Wayne University and the Michigan Department of Mental Health have announced that effective 1 July **Jacques S. Gottlieb** will assume the directorship of the nearly completed Lafayette Clinic, neuropsychiatric institution in Detroit. Gottlieb has served since July

1953 as director of the Institute of the Jackson Memorial Hospital in Miami, Fla., and as chairman of the psychiatry and neurology department at Miami University School of Medicine.

The $3,680,000 clinic, which is near the Wayne University medical building, will be staffed by College of Medicine personnel. Operational costs will be financed by the state. The new unit will have 145 beds, 25 devoted to children, and there will also be extensive out-patient facilities. A special classroom wing is attached to the four-story building. The clinic's program will include the training of psychiatrists, clinical psychologists, psychiatric nurses, psychiatric social workers, and personnel in allied professions.

The following appointments to assistant professor have been announced. University of Nebraska: **Herbert L. Davis,** biochemistry. University of Illinois, Urbana: **William J. Rutter,** biochemistry.

Necrology

Ernst P. Boas, 64, authority on heart and chronic diseases, advocate of compulsory health insurance law, author, former assistant clinical professor of medicine at Columbia University College of Physicians and Surgeons, New York, 9 Mar.; **William P. Boynton,** 87, professor emeritus of physics at Oregon State College, Corvallis, 9 Mar.; **Herbert W. Brandt,** 70, explorer, ornithologist, and author, Cleveland, Ohio, 8 Mar.; **Frank G. Brooks,** 61, head of the biology department at Cornell College, Mt. Vernon, Iowa, 4 Mar.; **Clement B. P. Cobb,** 54, assistant professor of pediatries at Cornell Medical School, Ithaca, N.Y., 11 Mar.; **Wirt E. Darrow,** 67, inventor, retired specialist in telephone switching engineering with Bell Telephone Laboratories, 14 Mar.

Alexander Fleming, 73, Nobel prize bacteriologist, discoverer of penicillin, retired director of the Wright-Fleming Institute of Microbiology at St. Mary's Hospital, London, 11 Mar.; **Hannibal C. Ford,** 77, electrical engineer, inventor, founder and former president of the Ford Instrument Co., Long Island City, N.Y., 12 Mar.; **Roberto Funaro,** 71, pediatrician and research nutritionist, New York, 11 Mar.; **L. N. Hampton,** 59, design engineer with Bell Telephone Laboratories, New York, 5 Mar.; **Ralph L. Johnson,** 81, former psychologist at Girard College, Philadelphia, Pa., 10 Mar.; **Lyman F. Kebler,** 91, retired chief of the drug division of the U.S. Department of Agriculture Bureau of Chemistry, Washington, D.C., 4 Mar.; **Helen King,** 85, research zoologist, retired professor of embryology at the Wistar Institute of the University of Pennsylvania, Philadelphia, 7 Mar.; **Paul A. McNally,** 64, vice president of Georgetown University and chairman of the physics department, formerly director of the university's astronomical observatory, regent and dean of the medical school, regent of the dental and nursing schools, and director of the Medical Center, Washington, D.C., 4 Mar.

Stephen L. Polyak, 65, neurologist, author, professor of anatomy of the eye at the University of Chicago, Chicago, Ill., 9 Mar.; **Patrick Quilty,** 82, civil engineer, former commissioner of water supply, gas and electricity, New York, 12 Mar.; **Robert J. Quinn,** 65, retired chemical engineer with Mathieson Chemical Corp., Tucson, Ariz., 8 Mar.; **Clarence H. Richardson,** 64, professor of mathematics at Bucknell University, Lewisburg, Pa., 13 Mar.; **Selden E. Rockwell,** 72, retired engineer with the U.S. Bureau of Reclamation, supervisor of construction on Hoover Dam, as well as Bahkra Dam in India, Santa Cruz, Calif., 14 Mar.; **George L. Sexton,** 72, chemist, engineer, president of Sexton Research Laboratories, St. Petersburg, Fla., 15 Mar.; **Allen H. Suggett,** 87, professor emeritus of orthodontics at the University of California, Berkeley, 8 Mar.

Meetings

The Committee of the American Physiological Society on Education Matters is sponsoring a workshop on the **Teaching of Physiology in Undergraduate Colleges** to be held 8–19 Aug. at the University of Connecticut, Storrs. Membership in the workshop will be limited to approximately 25 college teachers, and discussion leaders will include cellular, mammalian, comparative, and plant physiologists. The general theme will be the fitting of principles of physiology into the undergraduate curriculum.

Funds are available to pay travel expenses and living costs while at the workshop for those who attend. College teachers who wish to participate *should make application before 1 May* to the chairman of the committee for the workshop, Dr. C. Ladd Prosser, Physiology Dept., University of Illinois, Urbana.

Certain aspects of **thermodynamics** which are having an impact on engineering and engineering education will be the subject for a **conference for thermodynamics teachers** to be held at Pennsylvania State University 27–29 June, following the annual meetings there of the American Society for Engineering Education. Sponsored by the National Science Foundation and the American Society for Engineering Education, the conference will continue the study of basic science in engineering education.

Subjects on the program include: special industrial applications of thermodynamics; all engineers need thermodynamics; thermodynamics and irreversible processes; irreversible coupled flows; electric and magnetic phenomena; electrochemistry; statistical thermodynamics; rate processes; relaxation phenomena; and elastomer thermodynamics. Registration will be limited to 125. For information, write to Dr. William E. Ranz, Department of Engineering Research, Pennsylvania State University, University Park, Pa.

In conjunction with the centennial celebration of New York University's College of Engineering, the Section on Physical and Engineering Sciences of the **American Statistical Association** is sponsoring a meet-

ing in New York, 26–27 May. The session will be devoted to applications of statistical methods in physics, chemistry, astronomy, the earth sciences, and engineering.

The biology department of Harvard University has announced that the **Prather lectures** for 1954–55 will be given by Linus Pauling on the general subject, "Molecular structure and biological activity." The lectures will be open to the public and will be delivered at 5 p.m. at the university in Burr Hall, B.

18 Apr., "Abnormal human hemoglobin molecules in relation to disease."

20 Apr., "The structure of antibodies."

22 Apr., "Structural complementariness and biological specificity."

25 Apr., "The duplication of molecules."

The American Mathematical Society has announced that a **Symposium on Mathematical Probability and its Applications** will be held in connection with the 512th meeting of the society, which will take place at the Polytechnic Institute of Brooklyn in April. The symposium is sponsored jointly with the Office of Ordnance Research. Sessions are scheduled for 14 and 15 Apr., and the sessions of the regular meeting will start on the afternoon of 15 Apr. and continue through 16 Apr. During the regular meeting, invited addresses will be given by Åke Pleijel and R. D. Schafer.

The emphasis in the symposium will be on the role played by probability theory in the physical sciences. The first sessions will be devoted to the general topic of diffusion processes, with Paul Lévy, J. L. Doob, and William Feller as participants. An afternoon session on turbulence will consist of invited addresses by Eberhard Hopf, Guido Münch, and G. K. Batchelor. On 15 Apr. a session on the general topic of probability in classical and modern physics will be held. Marc Kac, S. M. Ulam, and B. O. Koopman will be the speakers.

The **Association of Southeastern Biologists,** the Southeastern Section of the Botanical Society of America, and the Southern Appalachian Botanical Club will hold their annual meetings jointly at The Citadel, Charleston, S.C., 21–23 Apr. On the first evening there will be a symposium on parasite problems in the Southeast, with M. D. Young (U.S. Public Health Service) as moderator, and E. C. Faust (Tulane University,) W. H. Wright (National Institutes of Health) and W. S. Bailey (Alabama Polytechnic Institute) as speakers.

The program of papers includes sections on cytogenetics (10 papers), parasitology (11), botany (13), zoology (13), and physiology (14). At another symposium, biology teaching will be considered. S. L. Meyer (Florida State College) is moderator, and the participants are I. C. Kitchen (Mississippi), F. H. Norris (University of Tennessee) and W. B. Baker (Emory University). B. D. Reynolds (University of Virginia), immediate past president of the ASB is scheduled to deliver an address entitled "Between the mountains," and on the final day field trips to the Bears' Bluff Laboratory and to Bulls Island have been arranged.

The 46th annual meeting of the **American Association for Cancer Research, Inc.,** will take place 14–17 Apr. in the St. Francis Hotel, San Francisco, Calif.

Education

In cooperation with the National Science Teachers Association of the National Education Association, 1201 16th St. NW, Washington 6, D.C., some 44 science-related industries and engineering firms will offer **summer-vacation employment** opportunities to high-school science teachers.

Three panel discussions, an alumni dinner, and several other events are being planned for the celebration 12–13 Apr. of the 75th anniversary of the beginning of medical education at the **University of North Carolina.** W. P. Richardson heads the special committee in charge of arrangements. One of the panels, that entitled "Financing medical education," will be moderated by Joseph Hinsey, dean of the Cornell University School of Medicine.

A special course in **radioactivity for secondary school science** teaching is being offered 8–29 July by the University of Tennessee. Each applicant must hold an undergraduate degree with a major in one or more of the biological or physical sciences; however, no previous course work or other experience with radioactivity is required. Enrollment is restricted to 24 students. For information write W. W. Wyatt, College of Education, University of Tennessee, Knoxville.

The University of Maryland has announced the **Institute of Acarology,** 27 June–16 July. Since its inception at Duke University in 1951, this program has provided an opportunity for entomologists, parasitologists, and zoologists to study mites and ticks. In line with the recent discoveries concerning the role of the Acarina in public health and agriculture, the program has been expanded; facilities have been increased and the staff has been enlarged by the participation of investigators from nearby institutions. The regular staff this year consists of Edward W. Baker, U.S. Department of Agriculture; Joseph H. Camin, Chicago Academy of Sciences; and George Anastos and G. W. Wharton, of the University of Maryland. Further information may be obtained from G. Anastos, Dept. of Zoology, University of Maryland, College Park, Md.

The **Harvard Summer School** and **Graduate School of Education** this year will continue their special program for secondary-school science teachers with three courses entitled "Recent developments in physical science," "Classroom use of recent developments in physical science," and "Materials and methods in the teaching of botany." A number of special fellowships

are available for these courses, which will last from 5 July to 17 Aug. Each course will carry four units of graduate credit. The fellowships will cover tuition and registration fees, and some will also include allowances toward room and board or travel expenses.

In addition to these courses for secondary-school teachers, there will be a course on "Science in the elementary school" for teachers and supervisors on the elementary level. For information, write to the Harvard Summer School, 2-N Weld Hall, Cambridge 38, Mass.

Available Fellowships and Awards

Applications for 1956–57 **Fulbright awards** for university lecturing and advanced research in Australia, Burma, Ceylon, India, New Zealand, Philippines, and Thailand must be submitted *no later than 15 Apr.* For detailed information write to the Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C.

Programs for Austria, Belgium and Luxembourg, Denmark, Egypt, Finland, France, Germany, Greece, Iraq, Italy, Japan, Netherlands, Norway, Pakistan, Sweden, the United Kingdom, and Colonial Dependencies will be announced in July, although applications will be accepted from 1 May through the closing date, 1 Oct. All these awards are exclusively for lecturing and research at the post-doctoral level; applicants must be U.S. citizens.

Tufts College has been asked by the Link Foundation to administer the latter's fellowship in **aviation psychology,** which will be awarded for the first time during the school year 1955–56. The fellowship provides a stipend of $1500 as well as exemption from tuition and fees. The award will allow the fellow to pursue a full-time graduate program leading to the M.S. degree in the department of psychology and to conduct thesis research in relation to the aviation research program of the Institute for Applied Experimental Psychology. Applicants should communicate with Dr. Leonard C. Mead, Dean of the Graduate School, Tufts College, Medford 55, Mass.

As a contribution to the meeting of the British Association for the Advancement of Science to be held in Bristol, 31 Aug.–7 Sept., Imperial Chemical Industries Ltd., publishers of the quarterly scientific review *Endeavour,* have offered the sum of 100 guineas to be awarded as prizes, known as the **Endeavour prizes,** for assays submitted on scientific subjects: first prize, 50 guineas; second prize, 25 guineas; and third prize, 15 guineas. Two special 5-guinea prizes will be given to competitors who have not passed their 18th birthday on 1 June. Because the primary purpose of these awards is to stimulate younger scientists to take an interest in the work of the British Association and to raise the literary standard of scientific writing, the competition is restricted to those whose 25th birthday falls on or after 1 June 1955.

The subjects for the essays are as follows: the earth's magnetism; man-made fiber; climatic changes; scientific aids to food supply; respiration; and new metals for engineers. The essays, which must be typewritten in English, should not exceed 4000 words in length, and only one entry is permitted from each competitor. All entries should be addressed to: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1. The envelope should be clearly marked "Endeavour Prize Essay." *The latest date for receipt of entries is 1 June 1955.* The successful competitors will be invited to attend the whole of the Bristol meeting, at which the prizes will be presented, and their expenses within the United Kingdom will be paid.

The essays must be submitted without signature. The competitor's full name and address and date of birth should be disclosed in a sealed covering letter attached to the essay and addressed to the Assistant Secretary of the British Association, who will acknowledge all entries. The names will not be disclosed to the judges until after the prize-winning essays have been selected.

In judging the essays, special attention will be paid to the originality of the approach to the subject, and great importance will be attached to literary style. The competitor's age will also be taken into account. The essay winning the first prize will be published in *Advancement of Science,* journal of the British Association.

Fellowships, scholarships, and staff appointments open to science and engineering students who come to the Massachusetts Institute of Technology for graduate study in 1955–56 have been announced by three departments at the institute. Advanced work in **food technology, mechanical engineering, and meteorology** is open to qualified graduates, and in these three departments programs of financial aid are available. Further information about these opportunities for graduate study may be obtained from each of the departments concerned.

Nominations are invited for the $500 **Kimble Methodology research award,** which is sponsored by the Kimble Glassware Division of the Owens–Illinois Glass Co. and administered by a committee of the Conference of State and Provincial Public Health Laboratory Directors. The candidate's work should be either (i) a fundamental contribution that serves as a base line for development of diagnostic methods that fall within the province of the public health laboratory; or (ii) the adaptation of a fundamental contribution to make it of use in a diagnostic laboratory.

Nominees must be citizens of the Uinted States or Canada, and the work submitted should have been completed since 1 Jan. 1950. Nominations received *after 30 May* will not be considered for 1955, but may be considered for 1956. For information, write to the chairman of the nominating committee, Dr. M. Scherago, Dept. of Bacteriology, University of Kentucky, Lexington.

In the Laboratories

A scientific center for basic **research in neurology** is to be built near Caracas, Venezuela, by Sentab contractors of Sweden. Already $3 million have been appropriated for the project. H. Fernandez-Moran, who has spent 8 yr studying neurology and cytology in Sweden, will head the center.

Albino Farms, supplier of laboratory animals for scientific research, has announced its relocation in Red Bank, N.J.

A new building, designed to improve the quality of research animals and having facilities for 2000 cages or about 12,000 breeders, has been added to the facilities of the **Roscoe B. Jackson Memorial Laboratory** at Bar Harbor. The modern structure has concrete and plastic-tile floors, fluorescent lighting, a ventilating system that changes the air every 5 min, and an automatic oil furnace with a hand-fired heater for use in case of power failure. It will serve as a segregation unit for the inbred strain of mice called the Blacks and Black hybrids that is much in demand for radiation research, chemotherapy work with transplantable tumors, and studies on response to hormones.

A proposal by the **Seminole Electric Cooperative, Inc.,** of Madison, Fla., to study the feasibility of small central station nuclear power plants has been approved by the Atomic Energy Commission and will be performed under the AEC's Industrial Participation Program. Seminole is a federation of five electric distribution cooperatives in northcentral Florida, which serve one of the highest fuel-cost areas in the country.

The E. P. McLean Engineering Co., has been employed by Seminole to coordinate and direct the study, which will run for one year and will be made at the expense of the cooperative. The object is to determine whether a nuclear power plant can be developed to produce electricity at costs below those current in Florida, and to judge the suitability of small plants with a 10,000-kw capacity for use in the systems of member cooperatives.

The Gelcar Co., distributors of products for bacteriological and orchid cultures, announces its opening at 1318 Nostrand Ave., Brooklyn 26, N.Y., under the direction of A. Weintraub.

Miscellaneous

Calvin Perry Stone, professor of psychology at Stanford University and a member of the faculty since 1922, died suddenly on 28 Dec. 1954. As a memorial, a loan fund has been established for the aid of doctoral students in the general field of experimental psychology at Stanford. Friends and colleagues are invited to contribute to the fund. Checks may be mailed to the executive head of the department of psychology, Robert R. Sears.

The Institute of Microbiology at Rutgers University is attempting to build a microbiological library, but unfortunately it has been forced to start with only the current issues of journals and texts. Therefore, an appeal is made to all who may be in a position to help. The library is interested in virtually every aspect of the broad field of microbiology, including biochemistry, and would **welcome the donation of books and journals.** It also offers its facilities for the housing of special collections.

The institute has adopted a very liberal policy with regard to use of the library by "outsiders," and volumes in the collection will be readily available through the interlibrary-loan service. It is felt that many individuals, industries, and laboratories could benefit from a fine library at the Institute of Microbiology.

The library would be happy to pay any transportation and handling costs incurred by those who contribute publications. Inquiries should be addressed to the librarian, Robert A. Day, Institute of Microbiology, Rutgers University, New Brunswick, N.J.

A competitive **examination for appointment of medical officers** to the regular corps of the U.S. Public Health Service will be held in various places throughout the country, 7–9 June. Appointments provide opportunities for career service in clinical medicine, research, and public health. They will be made in the ranks of assistant and senior assistant, equivalent to Navy ranks of lieutenant (j.g.) and lieutenant, respectively. Starting salaries for those with dependents range from $6017 to $6918.

Application blanks may be obtained by writing to the Chief, Division of Personnel, Public Health Service, Department of Health, Education, and Welfare, Washington 25, D.C. Completed forms must be received *no later than May 6, 1955.*

One of the feature articles in the April issue of **The Scientific Monthly** is "National defense against atomic attack" by Walter E. Todd, Willard S. Paul, and Val Peterson. This article is based on papers presented at a joint symposium of the National Academy of Economics and Political Science, Section K of the AAAS; and the National Social Science Honor Society, Pi Gamma Mu, that was held at the Berkeley meeting of the AAAS.

Other articles are "Orchestral acoustics," E. G. Richardson; "Statistics, experiment, and the future of biology," R. E. Blackwelder and L. E. Hoyme; "Vesalius and the Galenists," M. F. Ashley Montague; "Some oceanographic results of the Odyssey," W. E. Maloney; "Wanted: more ivory towers," Ward Pigman; and "Organic detritus in the metabolism of the sea," Denis L. Fox.

The "Science on the march" section deals with the procurement and transportation of rhesus monkeys for use in the Radiobiological Laboratory of the University of Texas and the U.S. Air Force. Letters are from Wayne Dennis, Hymen Diamond, Philipp G. Frank, William L. Roberts, and Edward L. Gordy. Twenty-nine books are reviewed in this issue.

Book Reviews

The Vitamins: Chemistry, Physiology, Pathology. vols I and II. W. H. Sebrell, Jr., and Robert S. Harris, Eds. Academic Press, New York, 1954. vol. I, xiii + 676 pp. Illus. $16.50; vol. II, xiii + 766 pp. Illus. $16.50.

This review is concerned with the first two volumes of a three-volume reference work intended as a comprehensive coverage of the fundamental knowledge about the vitamins. In the initial volume, vitamins A, carotenes, ascorbic acid, vitamin B_{12} and biotin are dealt with, since the vitamins were selected on an alphabetical basis. The second volume is concerned with choline, vitamin D, essential fatty acids, inositols, vitamin K, niacin, and pantothenic acid.

As the editors state, they "have attempted to provide a guide service to the new and complicated areas" of what once seemed simple. In the organization of each volume, the various phases of the individual vitamins are dealt with by a contributor chosen for his competence in a given special field. Emphasis is placed on the chemistry and physiology of the vitamins, as the editors felt that the assay methods and the clinical manifestations of the deficiencies and their treatment were covered rather adequately in other publications. These phases are not entirely omitted, but are dealt with rather generally and supported by an extensive bibliography for consultation. This is particularly true for sections on determinations of the vitamins and the early history of the vitamins.

The contributors to this well-organized work have succeeded admirably in clearing up some of the confusion that has tended to exist in some phases of vitamin research. The material is presented in an exceedingly clear, simplified, and easy to read manner without loss of purpose. These volumes should prove extremely valuable to all investigators involved in vitamin research and particularly to those seeking authoritative appraisal and information of fields in which they are not directly active. The chapter on vitamin B_{12}, for instance, clears up considerably the confusion that has been associated with this vitamin. More than 125 pages are devoted to this rather recent member of the vitamin family.

The chemistry of the vitamins is treated in a very creditable manner. For example, the chemistry of biotin is divided into sections on isolation, chemical and physical properties, constitution, synthesis, analogs, complex compounds, and specificity. A similar treatment was made of the other vitamins. Of great value are the tables and structural formulas which summarize the chemical and biological aspects. This is particularly true for niacin, choline, vitamins A, and the carotenes. Similarly, the tables on the vitamin content of natural materials and information summarized on requirements should be welcomed by nutritionists.

Controversial phases of research, such as the vitamin-B_{12} relationship to choline and methionine synthesis, are considered in an excellent manner. All statements are well documented and any injection of theory or opinion by the writer is clearly indicated.

These volumes should be a stimulation for research. Sections on fields for further study are clearly indicated, with questions on present knowledge raised throughout for additional stimulation. For example, with respect to ascorbic acid, the contributor states that "regardless of a vast amount of work already completed in the field of enzyme and hormone interrelations of the vitamin, not many, if any, of the problems have been settled." Similarly, another contributor states that "the biological role of the essential fatty acids has not been elucidated, and only a few pieces of isolated information bear on the matter."

Literature references are given as footnotes at the bottom of each page for convenience, with a subject and author index at the end of each volume. References are included through 1952 and with a large number for 1953. Remarkably few literature omissions and errors were noted.

There are numerous plates, particularly with respect to the effects of a deficiency of vitamin A, choline, or ascorbic acid. Additional plates would be desirable as regards several other vitamin deficiencies. The quality of some plates did not seem to do them justice, considering the price of the books. The relatively high cost of this series will, unfortunately, limit its general use to some extent.

H. E. Sauberlich

Department of Animal Husbandry and Nutrition, Alabama Polytechnic Institute

Zoology. Clarence J. Goodnight and Marie L. Goodnight. Mosby, St. Louis, 1954. 730 pp. Illus. $6.50.

Clarence and Marie Goodnight, who teach introductory zoology at Purdue University, have added another volume to the shelf of zoology textbooks. A rather casual check shows that there are 23 other introductions to zoology at the college level in print, along with at least 40 introductory biology textbooks. A review of any new one, then, ought to be comparative but that would be a gigantic undertaking.

The various textbooks differ greatly in organization. There are the principles approach, the evolutionary approach, the physiologic approach, the morphologic approach—and, of course, the "dynamic approach," and a currently fashionable man-centric approach. Each book, as the publishers invariably point out, represents a "new approach."

The Goodnights have attempted a sort of blend. After an introductory section on science and the scientific method, the nature of life, and the basis of animal classifications, they have 11 chapters on the

various vertebrate organ systems. This is followed by a section on the "cell as the basis of organic activity," which includes chapters on cell structure, embryology, genetics, and evolution. Then comes a section, occupying nearly half the book, on the animal kingdom, which is reviewed phylum by phylum. Finally, there is a short chapter on ecology.

Except for details of organization, I do not see that the Goodnight book differs very greatly from its fellows. Almost all of these zoology textbooks are written in that curious dehumidified prose that the mouse tried out on the victims of Alice's tears, which seems not to be effective even as a drying agent. This book, like the others, is full of big words that the student will forget the day after the final exam and full of facts that the student will also forget.

Science, in these introductory textbooks, becomes a cut-and-dried affair—and this the students are likely to remember. The first chapter of this book, like so many others, takes up the "scientific method"—the gathering of facts, the formulation of the hypotheses, on to the discovery of "scientific law." There is a good deal about patient observation and objective evaluation.

Somehow this unreal "scientific method" symbolizes for me all that seems wrong with our college introduction to science. Can the uncertainties, the doubts, the unknown not get any mention? Can we give no feel of the historical context in which science has developed? Can we not look at scientists as men, and at science as one product of their humanity? Sometimes I suspect that these teachers of introductory science really believe in this scientific method that they foist off on their students; and the students certainly learn to regurgitate it on the exams. There is no hint of the process so neatly summed up in a saying attributed to Gauss: "I have had my results for a long time; but I do not yet know how I am to arrive at them."

MARSTON BATES

Department of Zoology, University of Michigan

Streams, Lakes, Ponds. Robert E. Coker. Univ. North Carolina Press, Chapel Hill, 1954. xviii + 327 pp. Illus. + plates. $6.

This book is intended to be a fresh-water counterpart to the author's *This Great and Wide Sea.* That is, it is a book for that well-known abstraction the general reader and is at the same time useful as an introductory textbook. It is perhaps more suitable for the latter purposes (especially for courses in state colleges), since it is a competent, comprehensive summary of basic concepts, characteristics of various fresh waters and their biota. For such a book it is surprisingly up to date, with references up through 1953. As reading matter, however, it impresses me as somewhat static, perhaps because there is so much familiar detail in it. It is illustrated with some fine photographs (none in color, however) and line drawings. A usage unbecoming a university press is the printing of generic names in roman, while those of higher groups are more often than not in italics; the usage is inconsistent in any event. Nevertheless, the book well fills the gap between the technical presentations of Welch and Ruttner and the general ecology textbooks that skip lightly over limnology.

JOEL W. HEDGPETH

Scripps Institution of Oceanography, La Jolla, California

Trigonometry. Elbridge P. Vance. Addison-Wesley, Cambridge, Mass., 1954. viii + 158 pp. Illus. $3.

This is a compact and carefully edited textbook on plane trigonometry, attractive in format, and adaptable to courses for varying lengths. The approach is fairly standard with a few novel features. It begins with a discussion of one- and two-dimensional rectangular coordinate systems and an intuitive treatment of arc length. The distance formula is derived and plays an important role in numerous later proofs in general settings, for example, that of the length of a chord in a unit circle, the addition formulas, and the law of sines and of cosines.

The general angle is introduced early, and the definitions of the functions in terms of the ratios of the sides of a right triangle appear later as a corollary to the law of sines. Extensive use of radian measure is made throughout the book. Revolutions, degrees, and radians are treated simultaneously with their interrelationships. Radians are defined in terms of revolutions.

Although the emphasis throughout is on the analytic aspects of trigonometry rather than the computational, the solution of triangles is handled in a brief but excellent manner, including material on significant digits. Previous exposure to logarithms is assumed; however, a brief discussion, along with interpolation and the use of tables, is given in the appendix. The basic four-place tables needed are included.

Some novel features in the book are the derivation of the functions of 36° and 3°, some approximations for functions of small angles, an interesting treatment of complex numbers as ordered pairs of real numbers, and a final section on applications of the circular functions to periodic phenomena.

I noted only one typographical error (p. 94). Some minor criticisms are these: the Greek alphabet is not mentioned but portions of it are freely used; equations of curves shown in the figures are not given directly on the graphs; the functions of 30° and 135° are given, but not those for 45° or 60°, and "function" is nowhere defined. Also the false impression appears to be given (p. 53) that the only angles constructible with ruler and compass are those that are integral multiples of 3°. Important formulas are numbered, but no distinctive type is used.

The sections on angles, exact values of the functions for $\pi/5$, the general reduction formulas, and the inverse circular functions are somewhat ponderous and

probably would require additional clarification by the instructor.

The problem lists are adequate, and answers are given to the odd problems. A reasonable number of illustrative examples to the theory are given, and ample material occurs on identities and on trigonometric equations.

E. A. NORDHAUS
Department of Mathematics, Michigan State College

Tables of Integral Transforms. vol. II. Based in part on notes left by Harry Bateman. Bateman Project Staff, A. Erdélyi, Ed. McGraw-Hill, New York–London, 1954. xvi + 451 pp. $8.

This is the final volume of the Bateman Manuscript Project's tables of definite integrals. The first part of volume II continues the plan initiated in volume I [reviewed in *Science* **120**, 302 (1954)] of listing as many integrals as possible in the notation of transforms. The transforms tabulated here have never been tabulated extensively before: they are transforms in which the kernel is a Bessel function of some kind (not only the Hankel transform), fractional integrals, Stieltjes transforms, and Hilbert transforms. The second part of the volume contains assorted definite integrals, most of which are not in transform form. These integrals involve orthogonal polynomials, gamma functions and their relatives, Bessel functions and hypergeometric functions. As in volume I, there is an appendix, giving the notations used, so that each volume can be used independently.

R. P. BOAS, JR.
Department of Mathematics, Northwestern University

Monomolecular Layers. A symposium presented at the Philadelphia meeting of the AAAS. Harry Sobotka, Ed. AAAS, Washington, D.C., 1954. vii + 207 pp. Illus. $4.25; members, $3.75.

The recent progress in the study of monomolecular layers is aptly presented by current workers in the field. Included are "Modern film techniques and their application to biochemical reactions," by Hans J. Trurnit; "Determination of molecular weights of proteins by the horizontal surface balance," by E. Mishuck and F. Eirich; "Mechanical properties of the surface films on aqueous solutions of detergents," by A. P. Brady and A. G. Brown; "Study of adsorption at a solution-air interface by radiotracers," by J. K. Dixon, C. M. Judson, and D. J. Salley; "Deposited radioactive monolayers," by D. E. Beischer; "Hydrophobic monolayers and their adsorption from aqueous solution," by E. G. Shafrin and W. A. Ziswan; "Review of the properties of films at oil-water interfaces," by E. Hutchinson; "Chemical reactions of sample and mixed monomolecular layers," by Harry Sobotka and Shirley Rosenberg; and "Chemical reactions and electric potential in monolayers," by E. Havinga. Most of these sections are well balanced and illustrated summaries of talks presented at the symposium at the Philadelphia meeting. Each presents a well-balanced summary of historical background, experimental technique, practical applications, and current theory involved. Sufficient detail is given to convince the reader of the widespread utilities of film studies in the fields of physical, colloid, organic, and analytic chemistry, in addition to biochemistry and chemical engineering.

The new tools, including a recording ellipsometer, an automatic dipping device for building up a uniform series of step gages, a new horizontal surface balance accurate to .01 dyne, and techniques for the isolation of films directly from pure molten compounds are adequately illustrated. The authors all succeed in pointing out the potential usefulness of further study of two-dimensional chemistry.

H. A. FREDIANI
Process Research and Development, Merck & Co., Inc.

Das Glas im chemischen Laboratorium. Fritz Friedrichs. Springer, Berlin, ed. 2, 1954. viii + 144 pp. Illus. DM 16.50.

A chemical laboratory without glassware is unthinkable. Nevertheless, the average chemist knows very little about the substance glass, its history and manufacture. Fritz Friedrichs, who can look back on 40 years of activity in one of the world's leading manufacuring centers of laboratory glassware, makes an attempt to remedy this situation and introduces his book with a brief history of glass through the ages.

As a descendant of the founder of the first Thuringian apparatus glass manufacturing company and a partner of the leading house of Greiner and Friedrichs, Wertheim (Main), the author is uniquely qualified to give us a lively picture of the development of apparatus glass and the manufacture of different laboratory equipment. Guided by an authority, the reader learns what types of glasses are available and their main properties as far as they are interesting to the chemist. Even though we buy our laboratory equipment and take it for granted that our pipettes, burettes, thermometers, and so forth, are properly calibrated, it is of interest to learn how other instruments are made, which tools the glass blower uses, and what training he has to qualify him for the job.

After World War I the apparatus division of the German Chemical Society activated a program which led to a gradual standardization of the equipment and its dimensions. For example, from the 119 different types of apparatus for developing gases in the laboratory only a few were chosen to remain on the market. The decision as to which types were essential could be made only by carefully analyzing the advantages and disadvantages of each type of apparatus, both for the user and the manufacturer. In order to help the scientist select the proper condenser, suction pump, absorption flasks, and so forth, the author critically discusses their particular features.

The book is well written and has excellent pictures

(175) of the various pieces of standard equipment. References to the catalogue of Greiner and Friedrichs are supplemented by the numbers of the German standards (D.I.N.). The present trend toward the standardization of laboratory equipment and the manufacture of exchangeable parts will make this book valuable to everyone interested in the manufacture and use of chemical equipment.

W. A. WEYL

Department of Mineral Technology,
Pennsylvania State University

Practical Physiological Chemistry. Philip B. Hawk, Bernard L. Oser, and William H. Summerson. Blakiston (McGraw-Hill), New York, ed. 13, 1954. xvi + 1439 pp. Illus. $12.

The appearance of the 13th edition of *Practical Physiological Chemistry* by Hawk, Oser, and Summerson is a landmark in physiological chemistry, since this marks the 50th anniversary of a book which has been of inestimable value to laboratory workers in biochemistry and allied fields. The impressive list of collaborators includes workers of prominence in many fields of biochemistry.

In general, the organization of material has remained the same as in earlier editions, but the book has been completely reset in a more readable form. This is especially true of experimental procedures. The use of chapter numbers on each page will be of great assistance as there are numerous references to previous chapters. Although several chapters were rewritten, most were not, but rather the sections were expanded by discussions of new developments introduced at appropriate places. This method of revision has limitations, but in general has proved more satisfactory than might be expected.

Inclusion of new developments and concepts has increased the size by 116 pages. Little of the material from previous editions has been deleted and many of the classical experiments that were carried on into this edition are of greater historical than practical interest. One might question the necessity for including the procedural details for all these tests. This new edition contains many experiments covering modern developments in biochemistry, such as paper and column chromatography, microbiological methods, use of radioisotopes, and countercurrent distribution. Two new additions of interest to clinical laboratories are the sections on liver-function tests and micromethods in clinical chemistry. It is regrettable that greater recognition was not given to the microgasometric technics developed by Scholander and coworkers.

Although nearly half of the 13th edition is devoted to textual material, it is probable that this book will continue to find its greatest use as a laboratory manual and reference for experimental biochemistry.

FRANK R. BLOOD

Department of Biochemistry,
Vanderbilt University School of Medicine

New Books

Electroplating Engineering Handbook. A. Kenneth Graham, Ed.; H. L. Pinkerton, Asst. Ed. Reinhold, New York 22, 1955. 650 pp. $10.

The Psychiatrist and the Dying Patient. K. R. Eissler. International Universities Press, New York 11, 1955. 338 pp. $5.

Mosquitoes. Their bionomics and relation to disease. William R. Horsfall. Ronald Press, New York 10, 1955. 723 pp. $16.

Proto-Lima. A Middle period culture of Peru. A. L. Kroeber. Fieldiana: Anthropology, vol. 44, No. 1. Chicago Natural History Museum, Chicago, 1954. 157 pp. Paper, $4.

Laboratory Manual for Histology. J. F. Smithcors. Burgess, Minneapolis 15, 1954. 101 pp. Paper, $3.

Proceedings of the Conference on Auroral Physics. N. C. Gerson, T. J. Keneshea, and R. J. Donaldson, Jr., Eds. Geophysical Research Papers, No. 30. Sponsored by Dept. of Physics, Univ. of Western Ontario, and Geophysics Research Directorate, Air Force Cambridge Research Center, 1954 (Order from U.S. Dept. of Commerce, Office of Tech. Services, Washington 25). 450 pp.

Le Magnétisme des corps célestes, vol. 3, ***Les Aurores polaires et la luminescence nocturne.*** pt. IV of ***Physique cosmique.*** A. Dauvillier. Hermann, Paris, 1954. 142 pp.

Abstracts of the Literature on Semiconducting and Luminescent Materials and Their Applications. 1953 issue. Compiled by Battelle Memorial Inst. Wiley, New York 16; Chapman & Hall, London, 1955. 169 pp. Paper, $5.

National Advisory Committee on Research in the Geological Sciences, Fourth Annual Report 1953–54. Including survey of current research in the geological sciences in Canada, 1953–54. Geological Survey of Canada, Dept. of Mines and Technical Surveys, Ottawa, 1954. 117 pp. Paper, $0.50.

Laboratory Explorations in General Zoology. Karl A. Stiles. Macmillan, New York 11, ed. 3, 1955. 291 pp. Paper, $3.75.

Insanity, Art and Culture. Francis Reitman. Philosophical Library, New York, 1954. 111 pp. $3.75.

Grundriss der Allgemeinen Zoologie. Alfred Kuhn. Thieme, Stuttgart, Germany, ed. 11, 1955 (Order from Intercontinental Medical Book Corp., New York 16). 281 pp. $3.95.

Lectures on Partial Differential Equations. I. G. Petrovsky. Trans. by A. Shenitzer. Interscience, New York–London, Engl. ed. 1, 1954. 245 pp. $5.75.

An Introduction to Plant Taxonomy. George H. M. Lawrence. Macmillan, New York 11, 1955. 179 pp. $3.25.

The Language of Social Research. A reader in the methodology of social research. Paul F. Lazarsfeld and Morris Rosenberg, Eds. Free Press, Glencoe, Ill., 1955. 590 pp. $6.75.

The Human Organisms. Russell Myles De Coursey. McGraw-Hill, New York–London, 1955. 550 pp. $5.75.

Contributions to the Theory of Partial Differential Equations. Annals of Mathematics Studies, No. 33. L. Bers, S. Bochner, and F. John, Eds. Princeton Univ. Press, Princeton, N.J., 1954. 257 pp. Paper, $4.

The Volcanic Rocks of the Ross Archipelago. W. Campbell Smith. British Antarctic ("Terra Nova") Expedition, 1910, Natural History Rpt., Geology, vol. II, No. 1 British Museum (Natural History), London, S.W.7, 1954. 107 pp. Paper, £3.

Conflict. George Simmel. Chap. 4, "Der Streit," ed. 3 of *Soziologie*, 1923; trans. by Kurt H. Wolff. ***The Web of Group-Affiliations.*** George Simmel. Chapter on "Die Kreuzung sozialer Kreise," *Soziologie*, 1922; trans. by Reinhard Bendix. Free Press, Glencoe, Ill., 1955. 195 pp. $3.50.

A Manual of Paper Chromatography and Paper Electrophoresis. Richard J. Block, Emmett L. Durrum, and Gunter Zweig. Academic Press, New York 10, 1955. 484 pp. $8.

Anthropological Papers. Nos. 43–48. Bull. 157. Bur. of American Ethnology, Smithsonian Institution, Washington, 1955 (Order from Supt. of Documents, GPO, Washington 25). 415 pp. Paper, $2.75.

The Fossil Evidence for Human Evolution. An Introduction to the study of paleoanthropology. W. E. Le Gros Clark. Univ. of Chicago Press, Chicago 37, 1955. 181 pp. $6.

6-Mercaptopurine. vol. 60, art. 2, Annals of the New York Acad. of Sciences. Roy Waldo Miner, Ed. The Academy, New York 21, 1954. 325 pp. Illus. Paper, $4.50.

Variable Stars and Galactic Structure. Cecilia Payne-Gaposchkin. Athlone Press, Univ. of London, London, W.C. 1, 1954 (U.S. Distrib.: de Graff, New York 10). 116 pp. $3.50.

The Medical Care of the Aged and Chronically Ill. With particular emphasis on degenerative disorders, advanced cancer and other as yet incurable diseases. Freddy Homburger. Little-Brown, Boston, 1955. 253 pp. $5.75.

The Harvey Lectures. Ser. 49 (1953–1954). Academic Press, New York 10, 1955. 299 pp. $7.50.

Baruch Spinoza and Western Democracy. An interpretation of his philosophical, religious and political thought. Joseph Dunner. Philosophical Library, New York 16, 1955. 142 pp. $3.

Atoms for Peace. David O. Woodbury. Dodd, Mead, New York, 1955. 259 pp. $3.50.

La Mécanique au XVII^e Siècle (des antecédénts scolastiques à la pensée classique). René Dugas Dunod, Éditeur, Paris 6, 1954. 620 pp.

Land-Use in the Ramah Area of New Mexico. An anthropological approach to areal study. John L. Landgraf. Rpts. of the Ramah Project, No. 5. vol. XLII, No. 1, Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard Univ. The Museum, Harvard Univ., Cambridge 38, 1954. 98 pp. Paper, $1.65.

Physicochemical Calculations. E. A. Guggenheim and J. E. Prue. Ser. in Physics, J. De Boer, H. Brinkman, and H. B. G. Casimir, General Eds. Interscience, New York 1; North-Holland, Amsterdam, 1955. 491 pp.

The Greatest Puzzle of All. Clarkson Dye. Westside Pub. Saratoga, Calif., 1954. 77 pp.

A Laboratory Manual for Soil Fertility Students. Darrell A. Russel and George Stanford. Brown, Dubuque, Ia., ed. 2, 1954. 59 pp. Paper, $2.

Patent Law in the Research Laboratory. John Kenneth Wise. Reinhold, New York 22; Chapman & Hall, London, 1955. 145 pp. $2.95.

Mental Health and Mental Disorder. A sociological approach. Prepared for a committee of the Society for the Study of Social Problems. Arnold M. Rose, Ed. Norton, New York 3, 1955. 626 pp. $6.50.

The Romance of Trees in Fact and Fancy. Mary Funk Hazel. The author, 1717 R St., N.W., Washington, D.C., 1955. 117 pp. Paper, $2.50.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to *Science*, but to the publisher or agency sponsoring the publication.)

Mass Differences. A compilation of experimental atomic mass differences found from beta decay, reaction energies, microwave data, alpha decay, and mass doublets. Nuclear Science Ser., Rpt. No. 16. Natl. Acad. of Sciences–Natl. Research Council, Washington 25, 1954. 145 pp.

Photographic Dosimetry of X- and Gamma Rays. Handbook 57. Margarete Ehrlich. Natl. Bur. of Standards, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 28 pp. $0.15.

Kausalität, Teleologie und Willensfreiheit als Problemkomplex der Naturphilosophie. Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin, Klasse für Mathematik und allgemeine Naturwissenschaften, Jahrgang 1954, No. 1. Hans Ertel. Akademie-Verlag, Berlin, 1954. 29 pp. DM. 1.70.

The 57th Report on Food Products and the 45th Report on Drug Products, 1952. Bull. 585. H. J. Fisher. Connecticut Agr. Expt. Sta., New Haven, 1954. 77 pp.

A Revision of Some Glanduline nodosariidae (Foraminifera). Misc. Coll., vol. 126, No. 3. Alfred R. Loeblich, Jr., and Helen Tappan. Smithsonian Institution, Washington 25, 1955. 9 pp.

Trials with Introduced Linseed Varieties in Southern Queensland. Div. of Plant Industry Tech. Paper No. 3. S. G. Gray. Comonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1954. 19 pp.

Fibrosis of the Liver in West African Children. Medical Research Council Special Rpt. Series, No. 285. J. H. Walters and J. C. Waterlow. Her Majesty's Stationery Office, London, 1954. 71 pp. 8s 6d.

National Institutes of Health Annual Lectures—1953. Public Health Service Publ. No. 388. U.S. Dept. of Health, Education, and Welfare, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 102 pp. $0.45.

The Vertebrate Organism. Handbook, pts. II and III. Howard H. Hillemann. The author, P. O. Box 491, Corvallis, Ore., 1954. 190 pp. Unbound ditto, $2.35.

The Mammals of the Huachuca Mountains, Southeastern Arizona. Illinois Biological Monogr., vol. 24, No. 1. Donald F. Hoffmeister and Woodrow W. Goodpaster. Univ. of Illinois Press, Urbana, 1954. 152 pp. Cloth, $4; paper, $3.

The Otariid Seals of the Pacific Coast of America. Bull.: Zoology, vol. 2, No. 10. Judith E. King. British Museum (Natural History), London, 1954. 28 pp. 8s.

State Highway Organization Charts. Highway Research Bd., Special Rpt. 20. Natl. Acad. of Sciences–Natl. Research Council, Washington 25, 1954. 52 pp. $0.75.

African Species of the Genus Pardomima Warren (Lepidoptera: Pyralidae: Pyraustinae). Bull.: Entomology, vol. 3, No. 14. Edward L. Martin. British Museum (Natural History), London, 1955. 18 pp. 7s.

Table of Salvo Kill Probabilities for Square Targets. NBS Applied Mathematics Ser. 44. Natl. Bur. of Standards, Washington 25, 1954 (Order from Supt. of Documents, GPO, Washington 25). 33 pp. $0.30.

Revisional Notes on the Genus Epitola Westwood (Lepidoptera: Lycaenidae). Bull.: Entomology, vol. 3, No. 13. Patrick Roche. British Museum (Natural History), London, 1954. 13 pp. 8s.

Technical Papers

Effect of N-1-Naphthyl Phthalamic Acid on Fruit Set of Peaches

L. J. Edgerton and M. B. Hoffman

Department of Pomology, Cornell University, Ithaca, New York

In an orchard test designed to evaluate several chemicals as spray thinning agents for peaches in 1953, it was found that N-1-naphthyl phthalamic acid (NPA) effectively reduced set when applied at bloom. This chemical had been included in this test on the basis of its effectiveness in reducing fruit set on certain ornamentals (*1*).

Limbs on Halehaven and Redhaven peach trees were sprayed with 500-ppm aqueous solution of NPA at approximately full bloom. This concentration resulted in excessive thinning, with only 1.3 percent of the flowers setting fruit on the Halehaven compared with 33 percent for the controls, and 1.6 percent of the flowers setting fruit on Redhaven compared with 30 percent for the controls. However, leaf development and growth following the treatments were normal, and the fruits that did set developed to excellent size. Even though these preliminary tests with NPA were conducted on relatively young trees, which are more responsive to chemical thinning sprays, it was apparent that the concentrations employed were too high.

Tests in 1954 were made (*2*) on mature trees having a good bloom and with promise of a heavy fruit set. Entire trees were sprayed, with eight trees per treatment. A high-pressure orchard sprayer was used for applying the treatments and the trees were sprayed to a point of moderate runoff to insure thorough coverage. Concentrations of 200 and 400 ppm were used on July Elberta and 150 and 300 ppm on Elberta. The application dates for the two varieties were approximately 3 days past full bloom (Table 1). Flowers were counted on two representative limbs on each tree at bloom, and fruit counts were obtained on the same limbs on 20 July to determine percentage of flowers setting fruit.

Thinning effects were evident on the treated trees within 10 days after the spray application, with many of the flowers becoming shriveled and dropping from the trees. The higher concentrations with both varieties resulted in excessive thinning, whereas the lower concentrations reduced the flower set to about the optimum level (Table 1). Foliage and shoot growth were excellent at the lower concentrations, with no visible injury apparent. Some of the July Elberta trees receiving 400-ppm NPA showed slight injury in the form of yellowing of occasional leaves on the weaker shoots, but the trees appeared normal at harvest time. However, it would not be necessary to employ such a high concentration on this variety.

In addition, NPA applications were made on 8 June, approximately 5 wk after bloom, on July Elberta to evaluate the possibility of NPA as a thinning agent at that time. The 400-ppm treatment resulted in appreciable thinning, but it was insufficient for these trees (Table 1). A comparable degree of thinning was obtained on Halehaven in another orchard where NPA at 400 ppm was applied, 5 wk after bloom. Although NPA will thin peach fruits when applied at this time, it has resulted in some leaf injury and stunted growth when used at concentrations high enough to thin. Also, the later application does not accomplish the benefit in fruit size that is achieved by thinning at bloom time or shortly after.

Dinitro chemicals have been used with some success as thinning sprays for peaches applied at bloom (*3*). However, their more extensive use is limited by the precise timing necessary to coincide with proper bloom stage and, in many instances, the lack of uniformity in bloom stage among trees in various parts of an orchard.

Experience with NPA suggests that this chemical is superior to dinitro as a thinning spray for peaches, since its thinning action is not dependent upon a particular stage of bloom. The possibility of applying NPA a few days after bloom would often permit more accurate appraisal of the need for thinning than would be possible at full bloom.

Experiments have been conducted and some experience has been gained with other chemicals that are effective in thinning peaches when applied about 1 mo after bloom. These include *a*-naphthalene acetic acid (*3*) and 3-chloro-isopropyl-N-phenyl carbamate (*4*). Where earlier thinning is warranted, NPA would have an advantage over these chemicals in achieving

Table 1. Fruit set of two peach varieties sprayed with N-1-naphthyl phthalamic acid (NPA).

Variety	Treatment	Date applied*	Flowers setting fruit 20 July (%)	Avg. fruit weight 20 July (g)†
July Elberta	NPA 200 ppm	5 May	7.8	
	NPA 400 ppm	5 May	3.9	
	NPA 200 ppm	8 June	18.3	
	NPA 400 ppm	8 June	15.2	
	Control		21.7	
	L.S.D. 5%		5.1	
	L.S.D. 1%		7.0	
Elberta	NPA 150 ppm	11 May	11.6	42.6
	NPA 300 ppm	11 May	4.1	
	Control		33.3	27.4
	L.S.D. 5%		5.9	
	L.S.D. 1%		8.2	

* July Elberta were in full bloom on 2 May; Elberta on 8 May.

† Average of 100 fruits collected at random from trees in two plots.

maximum benefit in fruit size. These characteristics of NPA would appear to justify further work with this chemical as a thinning agent for peaches and perhaps other fruits.

References and Notes

1. L. C. Chadwick, R. R. Miller, Donald Erskine, *Proc. Am. Hort. Soc.* **58**, 308 (1951).
2. The N-1-naphthyl phthalamic acid formulation (ACP-L-322) used in these studies was supplied by R. H. Beatty of the American Chemical Paint Co., Ambler, Pa.
3. L. P. Batjer and M. B. Hoffman, *U.S. Dept. Agr. Circ.*, No. 867 (1951).
4. P. C. Marth and V. E. Prince, *Science* **117**, 497 (1953).

23 December 1954.

Brief, Noninjurious Electric Waveform for Stimulation of the Brain

John C. Lilly, John R. Hughes, Ellsworth C. Alvord, Jr., Thelma W. Galkin

***National Institute of Mental Health* and *National Institute of Neurological Diseases and Blindness*, National Institutes of Health, U.S. Public Health Service, Bethesda, Maryland**

Long-term electric stimulation of the unanesthetized brain in animals and in man is becoming increasingly important in the fields of neurophysiology (*1*), psychology (*2*), and psychiatry (*3*). Despite indications that unidirectional pulses are injurious (*4*) their use in the afore-mentioned fields is quite extensive. In order to obtain reproducible results, injury to nerve cells by the passage of current must be avoided (*5*). We have found that one type of stimulating waveform does not injure the brain.

The processes that produce lesions by the passage of unidirectional pulses are apparently similar to those that produce lesions with small direct currents (*6*). The probable mechanisms of production of such lesions are those involving the displacement by the ionic current of charged particles (ions, enzymes, proteins, and so forth) from their key positions within and around the neurons. Presumably these displacements and the subsequent cellular destruction can be avoided by using sufficiently brief currents which pass an amount of electricity first in one direction and then an equal amount in the other within a short time. Conversely, any alternating waveform that has an additional small net flow in one direction will presumably cause net displacements and hence injury. If such a "zero net flow" waveform is brief enough, simple metallic nonreversible electrodes pass the current through the tissue without distortion of the waveform, and in addition the stimulus artifact is minimized.

With these points in mind, one of us in 1950 devised a waveform whose shape does not change with repetition frequency; it also has a net zero current and an invariant interval between the positive and negative peaks with change of frequency (Fig. 1). Despite the zero net flow and the brief time course of the pulse-pairs, it was found that such currents stimulate sensorimotor cortex and the responses to this stimulus are similar to those seen with rectangular pulses (*4*). These pulse-pairs probably are within the "constant coulomb threshold" region for nerve processes and cell bodies (*7*), and hence their absolute shape should not be critical.

The pulse-pairs (Fig. 1) are generated by quasi-differentiating (*8*) a rectangular pulse and amplifying the resultant with a Williamson type a-c amplifier that has a 100 key pass-band. The output of this amplifier is matched to the animal-electrode circuit by means of a high-frequency transformer (UTC-LS 63). The voltage drop across a 100-ohm resistor in series with the animal circuit is amplified and measured on a cathode-ray oscilloscope that has a pass-band of 0 to 10 Mcy (Tektronix type 535). This latter measurement is converted into current by calculation. By graphical integration on an enlarged photograph of these pulses, it has been shown that the quantity of electricity in the positive (upward) pulse is equal to that in the negative (downward) pulse within the experimental error of less than 0.4 percent. For a 10 ma peak current value, the quantity of electricity is about 0.2 μcoul per pulse.

In order to conduct these pulse-pairs through the cortex, an array of 25 or 36 electrodes is implanted over the sensorimotor cortex in a monkey with or without removal of the dura (*9*). This array is surrounded by a stainless steel ring screwed into the bone. The stimulating current is passed into the cortex from a given single electrode to the ring.

In our experiments, we have investigated the motor responses to these stimuli near the threshold (*4*). Pulse-pairs are used to stimulate the cortex on a schedule of a 2-sec train at 60 pulse-pairs per second every 30 sec for several hours a day.

A few results from observations on two unanesthetized monkeys (*Macaca mulatta*) are presented: the

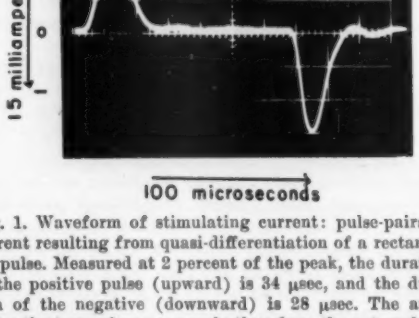


Fig. 1. Waveform of stimulating current: pulse-pairs of current resulting from quasi-differentiation of a rectangular pulse. Measured at 2 percent of the peak, the duration of the positive pulse (upward) is 34 μsec, and the duration of the negative (downward) is 28 μsec. The areas under the two pulses are equal; therefore, the net coulomb flow is zero for the pulse-pair algebraically summed during a time interval of 200 μsec from the beginning of the positive pulse.

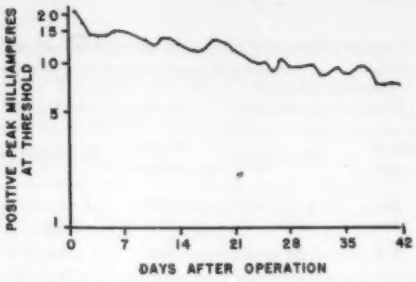


Fig. 2. Variation of threshold with time. The stimulus frequency is 60 pulse-pairs per second; the train duration is 2 sec; and the threshold is the positive peak current necessary to elicit a visible movement. The total quantity of the electricity for the positive pulse summed for the whole train is 18 μcoul. Time is given as days after operation. For the subsequent 9 wk, the threshold remained constant at the value shown at 42 days.

first monkey was observed for 7 wk; at the time of writing, the second monkey had been observed for 17 wk.

Figure 2 shows the slow fall of the threshold current (about 50 percent in the first month) for the pulse-pairs at 60 per second for a typical electrode during a period of 6 wk. Some of this decrease in threshold is probably due to recovery from anesthesia and operative trauma, and some to a slow decrease in distance between the electrode array and the cortex. In the earlier work with rectangular pulses, it was found that a relatively rapid increase in threshold takes place in a few hours (*4*).

Electrocorticograms taken from the electrodes showed no signs of injury. Neurological and behavioral examinations postoperatively showed only some minimal transient signs of injury. Slight flexor weakness in the contralateral hand was seen, but this weakness disappeared gradually during a period of 3 wk. We attribute this to mechanical operative trauma.

Some of the neurohistological studies (frozen sections) have been completed on the first monkey. Under the area of the trephined opening in the skull, there is a moderate proliferation of astrocytes and a slight meningitis. Minute amounts of lipid are present in a few macrophages in the leptomeningeal exudate but not elsewhere. The nerve cells are intact and have approximately the same appearance and population density as on the opposite, nonoperated hemisphere. Whether this degree of change is greater than that due to operative trauma alone remains to be determined.

From these results, it is concluded that this form of electric current does not detectably injure cellular function or structure when it is passed through the cortex near threshold values 4 to 5 hr per day for 5 to 15 wk. Other similarly balanced brief waveforms would probably give similar results. Further details of these observations and their interpretation are in preparation.

References

1. W. R. Hess, *Das Zwischenhirn* (Benno Schwabe & Co. Verlag Basel, 1949).
2. J. Olds, *J. Comp. and Physiol. Psychol.* **47**, 419 (1954).
3. R. G. Heath, *Studies in Schizophrenia* (Harvard Univ. Press, Cambridge, Mass., 1954).
4. J. C. Lilly, G. M. Austin, and W. W. Chambers, *J. Neurophysiol.* **15**, 319 (1952).
5. S. W. Ranson and H. W. Magoun, *Ergeb. Physiol.* **41**, 56 (1939).
6. S. W. Ranson and W. R. Ingram, *Am. J. Physiol.* **101**, 690 (1932).
7. B. Katz, *Electric Excitation of Nerve* (Oxford Univ. Press, London, 1939), p. 21.
8. B. Chance *et al.*, in *Waveforms* (Radiation Lab. Ser., vol. 19, McGraw-Hill, New York, 1949), p. 9.
9. J. C. Lilly, *Federation Proc.* **12**, No. 1, 285 (1953).

11 February 1955.

Use of Haploid and Diploid Embryos of *Habrobracon* in the Study of Cell Poisons

A. M. Clark and W. C. Beiser, Jr.

Department of Biological Sciences, University of Delaware, Newark and *Brookhaven National Laboratory, Upton, New York*

Various genetic and cytological tests have been used in the evaluation of the injurious effects of x-rays on cell nuclei. These have included the study of radiation-induced mutations and chromosome breaks. Additional means of evaluating substances that affect cell nuclei are needed. One such test for chemical agents is reported here and is based upon the fact that the radiosensitivity of cells and organisms may be modified by their degree of ploidy (*1, 2*).

Studies on the parasitic wasp, *Habrobracon juglandis* (Ashmead), have shown that haploid embryos are more resistant to x-rays than diploid embryos when the embryos are treated during the cleavage stages of development (*2*). Similar results have been obtained with the nitrogen mustard, methyl bis(beta-chloroethyl)amine hydrochloride (*3*). Since both x-rays and this nitrogen mustard compound are known to affect cell nuclei and also to be more injurious to diploid than to haploid embryos of *Habrobracon,* various other chemicals were tested (*4*). The fact that some chemicals were found to be more toxic to diploid embryos than to haploid embryos, whereas other chemicals were not, is of interest and points to the possibility that the criterion of greater toxicity to diploid than to haploid embryos might be of some use in the evaluation of cell poisons.

In *Habrobracon,* haploids develop from unfertilized eggs and diploids from fertilized eggs. Haploid cultures are obtained from unmated females, whereas cultures containing both haploid and diploid eggs ("mixed cultures") are obtained from mated females. Usually about 65 percent of the eggs from mated females are fertilized and, accordingly, are diploids. In material used in the present report, all haploids developed into males and all diploids into females. Eggs stored in the uterine sacs of the females remain

Table 1. Hatchability ratios for eggs from mated and unmated females (eggs treated during the cleavage stage).

Agent	Concn. (%)	Haploid + diploid (from mated females)		Haploid (from unmated females)	
		No. of eggs	Hatchability	No. of eggs	Hatchability
X-rays, 220 r (*2*)		331	0.18 ± 0.02	319	0.51 ± 0.03
Controls		1071	.92 ± .01	573	.93 ± .01
Methyl bis(Beta-chloroethyl)amine HCl* (*3*)	0.0010	878	.22 ± .01	837	.58 ± .02
Ethyl bis(beta-chloroethyl)amine HCl†	.0025	445	.19 ± .02	463	.74 ± .02
2,2′-Dichloro-diethylamine HCl‡	.0200	508	.16 ± .02	417	.53 ± .02
2,2′,2″-Trichloro-triethylamine HCl‡	.0025	269	.21 ± .03	240	.60 ± .03
Controls		543	.95 ± .01	432	.96 ± .01
Sodium azide	.0200	250	.46 ± .04	221	.39 ± .03
Potassium cyanide	.0025	108	.66 ± .05	133	.64 ± .04

* Obtained from Merck and Co., Inc. † Obtained from the Army Chemical Center, Md.
‡ Obtained from the University of Chicago Toxicity Laboratory.

in first meiotic metaphase, and further development does not take place until the eggs are laid (*5*). It is therefore easy to obtain timed embryos of known stages.

Eggs in the cleavage stage of embryonic development were placed in bags made of lens paper, immersed in test solutions of different nitrogen mustards for ½ hr, and then washed. They were then placed in mineral oil and allowed to continue development. The nitrogen mustard solutions were made up immediately before use and were kept at *p*H 7 by means of the Teorell buffer. The number of eggs that hatched as larvae was recorded. This incidence of hatchability (No. larvae/No. eggs) was used to compare the sensitivity of haploid and diploid embryos. Cultures (haploid) arising from unmated females were compared with mixed (haploid-diploid) cultures from mated females. These cultures were immersed in the same solution at the same time and were treated in the same way. In every case the haploid and the mixed cultures were paired. The hatchability values reported in Table 1 are averages from a number of such paired experiments.

Comparison of these cultures (Table 1) shows that for the nitrogen mustard compounds tested the hatchability of purely haploid cultures was greater than that for the haploid-diploid cultures. The same results were obtained for x-rays. The difference in hatchability between these two types of cultures is large and of the same magnitude for each of the nitrogen mustards that were tested, despite the fact that these mustards differ in their toxicity and probably in their mutagenic ability. Comparison of hatchability between haploid and mixed cultures treated with sodium azide or potassium cyanide shows no significant difference (Table 1).

Examination of whole mounts of embryos treated during the cleavage stage shows that embryos treated with x-rays or with the methyl bis(beta-chloroethyl)-amine hydrochloride are arrested in development at the end of cleavage and have enlarged nuclei (*2, 3*). The effects of the other compounds have not been studied cytologically.

Differential effects of chemical agents on individuals differing in their degree of ploidy have been reported for amphibians treated with chloretone (*6*) or with hexenolactone (*7*). It seems worthy of note that a closely related compound, beta-propiolactone, induces mutations in *Neurospora* and causes chromosomal aberrations in *Vicia faba* (*8*). The present work indicates that comparable studies on diploid and polyploid plants and particularly on haploid and diploid yeasts might be pertinent to the analysis of the action of chemicals on cells.

Such comparisons of the toxic effects of chemicals on groups of individuals that differ in their degree of ploidy seem to indicate the following possibilities: (i) a simple and convenient method of screening nuclear and nonnuclear poisons might be obtained; (ii) a method of distinguishing mutagens from nonmutagens or perhaps of separating mutagenic substances that cause gross chromosomal aberrations from mutagens that do not cause chromosome breaks might be obtained; and (iii) further data might be secured on the mechanism of radiation damage by determining which of the chemicals are radiomimetic in this respect.

References and Notes

1. L. Smith, *J. Agr. Research* **73**, 137 (1946); R. Latarjet and B. Ephrussi, *Compt. Rend. Acad. Sci. Paris* **29**, 306 (1949).
2. A. M. Clark and C. J. Mitchell, *Biol. Bull.* **103**, 170 (1952).
3. A. M. Clark and W. C. Beiser, Jr., *Nature* **171**, 178 (1953).
4. Research carried out under AEC contract AT(30-1)-953 with the University of Delaware and at the Brookhaven National Laboratory under the auspices of the U.S. Atomic Energy Commission.
5. A. R. Whiting, *Am. Naturalist* **79**, 193 (1945).
6. G. Fankhauser, *Quart. Rev. Biol.* **20**, 20 (1945).
7. R. Briggs, *Growth* **10**, 45 (1946).
8. H. H. Smith and A. M. Srb, *Science* **114**, 490 (1951).

16 December 1954.

Incorporation of Radioactive Glycine into Proteins of Frog Oocytes

Norman E. Kemp

Department of Zoology, University of Michigan, Ann Arbor

Recent work on the cytology of yolk synthesis in amphibians has been reported by Osawa (*1*), Wittek (*2*), Kemp (*3*), and Osawa and Hayashi (*4*). The last-named authors (*4*) have also presented biochemical evidence to show that protein continues to accumulate in oocytes of *Triturus pyrrhogaster* throughout the growth period in the ovary. Since the yolk platelets, according to Brachet (*5*), are composed chiefly of proteins, they provide a visible cellular inclusion convenient for studying protein synthesis. Friedberg and Eakin (*6*) and Eakin, Kutsky, and Berg (*7*) have published reports on the uptake of C^{14}-labeled glycine and S^{35}-labeled methionine into amphibian embryos; but it was noted (*6*) that the heavier fraction, containing the yolk of centrifuged embryos, took up comparatively little radioactive glycine from solution. One might expect, however, that amino acids would readily be incorporated into the yolk platelets during their synthesis in oocytes.

To test (*8*) this expectation 12 adult female frogs (*Rana pipiens*) obtained through a dealer in Wisconsin during the last week in July 1953 were injected intrapleuroperitoneally with C-2-C^{14}-labeled glycine purchased from Tracerlab, Inc. Six animals received 10 μc of the radioactive glycine dissolved in distilled water, and six received 20 μc. Two animals in each group of six were sacrificed at intervals of 1, 3, and 5 days after injection. Samples of stomach, liver, intestine, kidney, lung, brain, hand, and heart, as well as ovary, were fixed in Bouin's fluid for sectioning. Duplicate samples of each organ (brain omitted) and samples of blood collected from the ventricle were homogenized with 10-percent trichloroacetic acid in a Ten Broeck grinder. The fixed tissue was imbedded in paraffin (mp 56°–58°C) and sectioned at 10 μ. Sample slides were stained wtih hematoxylin and eosin. Slides of neighboring sections were used for making autoradiograms on Eastman medium-contrast lantern-slide plates after the technique of Dent and Hunt (*9*). Sections of tissues from a normal, uninjected animal served as controls for the radioactive tissues. Proteins precipitated with trichloroacetic acid were purified and isolated according to the technique of Levine and Tarver (*10*). Samples were plated on aluminum disks and were counted with a thin, end-window Geiger-Müller tube (TGC-2) obtained from Tracerlab, Inc. Counts were corrected for background, coincidence, and self-absorption.

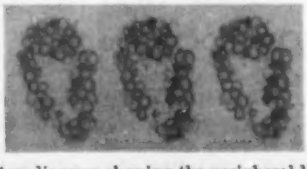


Fig. 1. Autoradiogram showing the peripheral localization of radioactivity in oocytes of a section of ovary from frog No. 4, injected with 10 μc of radioactive glycine and sacrificed 3 days later. (×4)

Table 1. Specific activity (counts/min mg) of samples of isolated proteins from tissues of six animals injected with radioactive glycine.

Samples	Animals injected with 10 μc			Animals injected with 20 μc		
	1	3	5	7	9	11
Kidney	151	128	183		497	618
Ovary	160	60	149	211	373	602
Liver	65	87	80	114	153	557
Intestine	61		17	147	157	477
Heart	69	65	54		232	361
Stomach	37	55	29	119		454
Hand	53	75	27	182	231	320
Lung	40	58	33	149	232	418
Blood		46	149	326	125	281

Figure 1 is an enlargement of an autoradiogram of a section of ovary from an animal injected with 10 μc of radioactive glycine and sacrificed 3 days later. The larger oocytes in this ovary were in stage Y_2 (*3*) with respect to deposition of yolk, and it is clear that radioactivity is highest at the periphery of these oocytes. None of the small oocytes in preyolk stages and interspersed among those containing yolk had sufficient radioactivity to sensitize the photographic film appreciably. Similar autoradiograms were obtained from other animals. It seems justifiable to conclude from these observations that radioactive glycine is selectively incorporated into the peripheral cytoplasm of cells that are actively synthesizing yolk. Unfortunately, the resolution of the autoradiographic technique used is not good enough to disclose at present what particular cytoplasmic components possess the highest radioactivity.

The specific activity of the isolated protein samples from single animals of each postinjection age, in both dosage groups, is shown in Table 1. Animals 1 and 7 were sacrificed 1 day after injection, animals 3 and 9 on the third day, and animals 5 and 11 on the fifth day. Data for the other six animals injected are similar. It can be seen that in general the figures for animals receiving injections of 20 μc run appreciably higher than those for animals injected with 10 μc. Because of individual variations, comparisons among animals in this limited series are not particularly significant; but counts on the different tissues for a given animal do reflect differences in level of incorporation. The various organs are arranged in Table 1 in order of decreasing relative activity. The ovary was among the three highest organs with respect to specific activity of incorporated glycine in nine of 12 animals

studied; and oocytes in the ovaries of the three animals exhibiting a relatively lower activity (for example, animal 3, Table 1) were either in preyolk stages or in early stages of the deposition of yolk. Further experiments with animals at graded stages of vitellogenesis are in progress to furnish more precise information on the correlation between the uptake of glycine and the synthesis of yolk.

References and Notes

1. S. Osawa, *Embryologia* **2**, 1 (1951).
2. M. Wittek, *Arch. biol.* **63**, 133 (1952).
3. N. E. Kemp, *J. Morphol.* **92**, 487 (1953).
4. S. Osawa and Y. Hayashi, *Science* **118**, 84 (1953).
5. J. Brachet, *Chemical Embryology* (Interscience, New York, 1950).
6. F. Friedberg and R. M. Eakin, *J. Exptl. Zool.* **110**, 33 (1949).
7. R. M. Eakin, P. B. Kutsky, W. E. Berg, *Proc. Soc. Exptl. Biol. Med.* **78**, 502 (1951).
8. This work was aided by a grant from the Michigan Memorial-Phoenix Project.
9. J. N. Dent and E. L. Hunt, *J. Exptl. Zool.* **121**, 79 (1952).
10. M. Levine and H. Tarver, *J. Biol. Chem.* **184**, 427 (1950).

17 December 1954.

Crystal Structure of Rutherfordine, UO_2CO_3

C. L. Christ, Joan R. Clark, H. T. Evans, Jr.

U.S. Geological Survey, Washington 25, D.C.

Crystals of the mineral rutherfordine, UO_2CO_3, used in this study (*1*) are pale yellow to brown and are lathlike elongated along [001], with large (100) and somewhat less dominant (010). Cleavage parallel to (010) is perfect. Precession and Weissenberg patterns yield the following data: orthorhombic, space group—$Pm2_1n$ (C_{2v}^7) or $Pmmn$ (D_{2h}^{13}); cell contents, $2UO_2CO_3$; $a = 4.84_5 \pm 0.010$ A; $b = 9.20_5 \pm 0.008$; $c = 4.29_6 \pm 0.006$; density (calc.) $= 5.72_4$ g cm^{-3}. (Moλ: $K_\alpha = 0.71069$ A, $K_{\alpha_1} = 0.70926$ A). Miller *et al.* (*2*) found the density of synthetic UO_2CO_3 to be 5.7 g cm.$^{-3}$

All of the observed reflections obey the criterion $h + k + l = 2n$, except a very weak set that appears only on strongly exposed photographs; for this set when $h + k = 2n$, $l = 2n + 1$, and when $h + k = 2n + 1$, $l = 2n$. The intensities of the strong reflections follow an essentially normal atomic form-factor decline with increasing $\sin\theta/\lambda$.

Through consideration of these experimental results and a knowledge of the nature of the uranyl ion, $(O\text{-}U\text{-}O)^{++}$—namely, that it is collinear (*3*) and has U-O distances of 1.93 A (*4*)—it was possible to derive the structure of UO_2CO_3 without recourse to quantitative intensity measurements. This structure is illustrated in Figs. 1 and 2 (top). It is isomorphic with the space group $Pmmn$ and has the following atomic parameters (assuming C-O distances of 1.28 A).

2 U at (b): $\pm(\frac{1}{4}, \frac{1}{4}, z)$; $z = 0.750$
2 C at (a): $\pm(\frac{1}{4}, \frac{1}{4}, z)$; $z = 0.601$
2 O_I at (a): $\pm(\frac{1}{4}, \frac{1}{4}, z)$; $z = 0.303$
4 O_{II} at (e): $\pm(\frac{1}{4}, y, z; \frac{1}{4}, \frac{1}{2} - y, z)$; $y = 0.960$, $z = 0.750$
4 O_{III} at (f): $\pm(x, \frac{1}{4}, z; \frac{1}{2} - x, \frac{1}{4}, z)$; $x = 0.021$, $z = 0.750$
(origin at $\bar{1}$)

The structure described is the ideal one for rutherfordine. Actually, the x-ray patterns of the crystals examined exhibit diffuse streaking, in the direction of the b^*-axis, of the weak reflections. This observation is explained in the following way. The carbonate groups may in alternate layers point in opposite di-

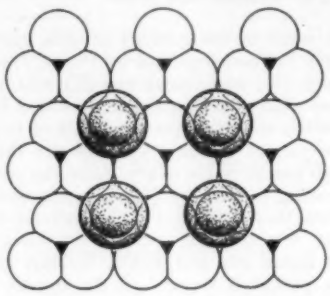


Fig. 1. Structure of a layer in UO_2CO_3, parallel to (010). The UO_2^{++} groups lie normal to the plane with the uranium atoms lying in the hexagonal holes formed by the carbonate groups. Each uranium atom has six bonds lying in the plane, with distances U-O_{III} (4) = 2.52A, U-O_I (2) = 2.43 A, and two bonds normal to the plane with U-O_{II} = 1.93 A (assumed).

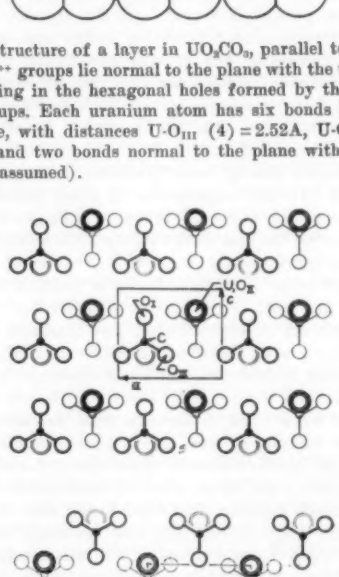


Fig. 2. Structure of UO_2CO_3 projected on (010). The atoms drawn in heavy lines all lie in one plane, those drawn in light lines in another plane, with the two planes separated by $b/2 = 4.60$ A. Structure A (ideal) (top) and structure B (bottom) differ in the way that the CO_3^{--} groups point in successive layers.

rections along the c-axis, as in the ideal structure (structure A, Fig. 2), or in the same direction (structure B, Fig. 2), without appreciably changing the environment of any atom. Hence, the two structures must be energetically nearly equivalent. As a result, in actual crystals of rutherfordine, faults occur in the stacking of the layers; regions in which the sequence of layers corresponds to structure A are occasionally terminated by regions in which the layers follow the sequence of structure B. There is evidence that the degree of disorder may differ significantly from crystal to crystal, perhaps as a function of the age of the crystals. This situation has not yet been completely analyzed.

References and Notes

1. Publication of this paper was authorized by the director of the U.S. Geological Survey. This work was completed as part of a program undertaken by the U.S. Geological Survey on behalf of the Division of Raw Materials of the U.S. Atomic Energy Commission. We are indebted to Clifford Frondel of Harvard University for the mineral specimen from which the crystals of rutherfordine were obtained. A detailed discussion of the structure of rutherfordine, particularly of the nature of the disorder and its mineralogical implications is in preparation.
2. P. D. Miller, H. A. Pray, H. P. Munger, U.S. Atomic Energy Comm. Rpt. AECD-2740, Aug. 1949.
3. I. Fankuchen, *Z. Krist.* **91**, 473 (1935); W. H. Zachariasen, *Acta Cryst.* **1**, 277 (1948).
4. F. H. Ellinger and W. H. Zachariasen, *J. Phys. Chem.* **58**, 405 (1954).

15 December 1954.

Communications

Big Business and Research

R. W. Lippman has made a comment [*Science* **120**, 1036 (1954)] about big business and scientific research that runs counter to my own experience. I think it creates, moreover, a rather false notion of the way many business corporations look on the role of basic science in today's world. Lippman states that anyone who has tried to find money for basic research from business organizations knows the difficulties. He states that even what business calls basic research is not that but, rather, something of limited scope and usually directed toward the solution of a specific project in which the company has a direct business interest.

It is true that responsible officers of large corporations often feel that their support of basic scientific research must be directed toward something with relevance to the operations of the company. But this does not mean that such officers seek to impose limitations on the nature of the research, its directions, or its outcome. Moreover, there is a fast-growing tendency for the managements of many large corporations to make very liberal interpretations of the interests of the companies in judging what is proper for them to support.

Our observatory has just completed the construction of a new solar laboratory made possible by some 37 nongovernment donors. The building will be used for fundamental research in solar astronomy. No specific company will gain direct benefit from our research, although the welfare of the nation as a whole will be advanced. No "practical" goals have been set for our study, and no conditions of any sort have been imposed by any donor. I have just made a quick count, and, of the 37 contributors, 11 were corporations, six of which are definitely in the category of "big business." In addition, at least nine contributions were made by individuals who were primarily businessmen. Moreover, seven additional contributions were given by foundations established by men who had made their fortunes in business.

Naturally we expect that our basic research will have widespread practical application and, thus, will materially benefit a wide variety of interests. But no individual company can expect to be preferentially aided. The support so generously given is for basic research—and the fact that such support is available is an evidence, to my mind, of the sound insight of these business executives into the role of fundamental science in modern life.

WALTER ORR ROBERTS

High Altitude Observatory,
University of Colorado, Boulder

14 January 1955.

Influence of Humic Acids on Plant Growth

Recently attention has been paid to the ferric chelate of ethylenediamine tetraacetic acid (EDTA) as a source of iron for plants in nutrient culture (*1*) and for chlorotic fruit trees (*2*). Evidence that the FeEDTA molecule was absorbed and translocated as a whole was provided by supplying FeEDTA containing isotopically labeled nitrogen, whereupon it was found that the amounts of iron and isotopic nitrogen reaching the leaves were in stoichiometric agreement (*3*).

In recently described experimental work (*4*) in which the roots of a sunflower plant were divided so as to absorb nutrients from two containers, it was demonstrated that the plant grew healthily if EDTA was supplied to one compartment and iron and phosphate to the other, whereas the plants became chlorotic if EDTA was omitted.

In our earlier work (*5*) we showed that the growth-promoting effect of a lignite was the result not of its trace-element content but of humic substances that made iron in the nutrient solution readily available (*6*), even in the presence of high phosphate. Iron chlorotic plants were found to have high concentrations of iron in the roots, probably immobilized as

complex ferric phosphates. This indicated that the effect of humic acids was not merely an ion exchange at the root surface, but that the translocation of iron to the leaves was being promoted. This could be demonstrated by a split-root technique, and experiments with tomatoes were in progress when the afore-mentioned report (*4*) appeared. Our results are therefore briefly presented here (*7*).

We have been able to confirm that EDTA, absorbed by the roots in one compartment, caused translocation to the leaves of iron supplied in the presence of high phosphate from the roots of the other compartment. Within 1 mo about two-thirds of the EDTA supplied had disappeared.

If a water extract of peat was used instead of EDTA the plants grew equally healthily. Humuslike substances synthesized from "A.R." sucrose (*8*) were equally effective in preventing iron chlorosis. The plants became chlorotic if the humic water was withdrawn.

A ratio of phosphorus to iron in healthy leaf cells varies within narrow limits, chlorotic leaves having either high (iron deficiency) or low (iron toxicity) ratios (*5*). If ferric chloride was supplied to one compartment and phosphate to another, the plants continued to grow healthily. It would appear that it is the level of soluble iron in the cells of the root that determines how much iron will be translocated to the leaf. A more detailed description of these experiments is in preparation.

P. C. DE KOCK

Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen

References and Notes

1. L. Jacobson, *Plant Physiol.* **26**, 411 (1951).
2. I. Stewart and C. D. Leonard, *Science* **116**, 3201 (1952).
3. A. Wallace and C. P. North, *Calif. Agr.* **7**, No. 8, 10 (1953).
4. L. H. Weinstein, W. R. Robbins, and H. F. Perkins, *Science* **120**, 41 (1954).
5. P. C. de Kock and E. L. Strmecki, *Physiol. Plantarum* **7**, 503 (1954).
6. D. Burk, H. Lineweaver, and C. K. Horner, *Soil Sci.* **33**, 413 (1933).
7. We are indebted to E. G. Williams for helpful discussion.
8. C. K. Horner, D. Burk, and S. R. Hoover, *Plant Physiol.* **9**, 663 (1934).

10 January 1955.

Improved Adhesion and Visibility of Cytologic Preparations by Use of the Frosted Glass Slide

Frosted glass may be used to good advantage as an aid in the adhesion of material to a glass slide in the preparation of various types of nonmucoid fluids and secretions for microscopic study. The slide discussed here is frosted or etched on the entire surface of one or both sides and is referred to as the *frosted glass slide* [U.S. Pat. pending].

During the process of staining cellular material spread over a conventional type of slide (only one side frosted on one end for easy marking purposes),

Fig. 1. (Left) Unmounted slide showing material smeared on both frosted and clear surfaces. (Right) Same slide when mounted with a cover glass.

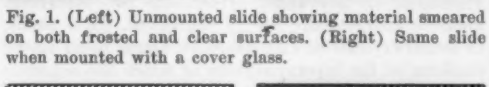


Fig. 2. (Left) Slide frosted on one surface. (Right) Slide frosted on both surfaces.

it was observed that, where the specimen partially covered the label end or frosted surface, it appeared more intense than on the clear surface. There was a distinct difference in the two areas, the line of change occurring at the boundary of the frosted edge. It was apparent that the material adhered more readily to the area of frosted glass than to the clear surface (Fig 1, left). After mounting (Fig. 1, right), the frosted glass was observed to be completely clear in the area of contact with the mounting medium.

These observations led to testing and then to use of the frosted glass slide for cytologic and histologic preparations. It was also found useful in bacteriologic, hematologic, and other laboratory studies. Experiments were performed using slides frosted from end to end on one or both surfaces and varying in degrees of grain (Fig. 2).

Frosted glass comparable to a 150-emery grain has proved most satisfactory for routine cytologic and histologic procedures; however, variations ranging from 120- to 170-emery grain may be used for the other preparations mentioned in the foregoing paragraph.

Principle A: adhesion of material. Cells, bacteria, and other inclusions found in body fluids and secretions adhere more readily to a frosted or etched glass surface than to a smooth one. One of the most serious problems in the cytology laboratory today is that of preparing smears to meet the cytologist's requirements for giving an accurate interpretation. Since many specimens encountered are nonmucoid, there is always the problem of a certain loss of important material. Routine staining procedures require much washing, which results in considerable loss of material, regardless of the amount of caution taken during processing.

Such substances as egg albumin are now being used for adhesive purposes. However, use of the frosted glass slide eliminates the need for such adhesive substances, which often obscure the important detail, especially in the examination of watery-type specimens. The slide frosted on one side is suggested for routine use (Fig. 2, left, 150-emery grain).

Principle B: diffusion of light. Frosted glass diffuses the light coming through the microscope and thus cuts down the glare and reduces eye fatigue. This is accomplished when the frosted surface is on the

under side. Therefore, the slide shown in Fig. 2 (left), with the specimen mounted on the smooth side, may be used for this purpose only. The slide etched on both sides (Fig. 2, right) serves the dual purpose of light diffusion and improved adhesion.

The frosted glass slide should also find a place in high-school, university, and other laboratories where the majority of students work with an inexpensive and a comparatively poor light source.

In Fig. 3 (left and right), it is shown that the mounting medium completely clears the frosted glass in the mounted or contact area. It should also be noted that the light diffusion is equal in Fig. 3 (middle and right).

Figure 3 (right) illustrates the mounted slide frosted on both surfaces. The contact surface is transparent, but the frosted glass on the under surface can still be seen.

In bacteriologic, hematologic, or other studies where mounts are not required for routine work, the immersion oil used to examine the specimens will clear the frosted glass. In this respect, it acts in the same manner as the mounting media, for example, permount, Canada balsam, and other substances that have substantially the same refractive index as glass.

The advantages of frosted glass slides over clear glass slides can be summarized as follows: (i) Increased adhesion of material to the slide results in a higher percentage of accuracy and assists the microscopist in his final evaluation or diagnosis. (ii) Light diffusion by use of the frosted glass slide cuts down glare and reduces eye fatigue, which is extremely important to the cytologist or pathologist who spends an unlimited amount of time at the microscope. (iii) The frosted glass slide is suggested for use in high-school and university laboratories, where the source of illumination for microscopic work is frequently of poor quality.

Fig. 3. (Left) Slide, as shown in Fig. 2 (left), mounted on frosted surface. (Middle) Slide, as shown in Fig. 2 (left), mounted on clear surface. (Right) Slide, as shown in Fig. 2 (right), mounted.

EVELYN STUART DAKIN

Laboratory of Cytopathology,
Roosevelt Hospital, New York

15 February 1955.

Association Affairs

AAAS Sections Call for Papers for the Atlanta Meeting

Ten sections of the Association will arrange sessions for contributed papers at the Atlanta meeting, 26–31 Dec. 1955. The secretaries to whom titles and brief abstracts should be sent, *not later than 30 Sept. 1955*, follow:

C—Chemistry. Dr. Ed. F. Degering, 26 Robinhood Road, Natick, Mass.

D—Astronomy. Dr. Frank K. Edmondson, Goethe Link Observatory, Indiana University, Bloomington, Ind.

E—Geology and Geography. Dr. Robert L. Nichols, Department of Geology, Tufts College, Medford, Mass.

F—Zoological Sciences. (If outside the scope of the American Society of Parasitologists and the Society of Systematic Zoology, which are meeting with the AAAS.) Dr. Harold H. Plough, Department of Biology, Amherst College, Amherst, Mass.

G—Botanical Sciences. (If outside the scope of the American Phytopathological Society, which is meeting with the AAAS.) Dr. Barry Commoner, Henry Shaw School of Botany, Washington University, St. Louis, Mo.

I—Psychology. Dr. William D. Neff, Department of Psychology, University of Chicago, Chicago, Ill.

L—History and Philosophy of Science. Dr. Jane M. Oppenheimer, Department of Biology, Bryn Mawr College, Bryn Mawr, Pa.

Nd—Dentistry. Dr. Russell W. Bunting, School of Dentistry, University of Michigan, Ann Arbor.

Np—Pharmacy. Dr. John E. Christian, School of Pharmacy, Purdue University, Lafayette, Ind.

Q—Education. Dr. Dean A. Worcester, University of Nebraska, Lincoln.

New Section Officers

As authorized by the Council of the AAAS at its meeting in Berkeley last December, the Board of Directors, on 20 Mar., approved the nominations of two of the Association's sections, as follows:

Vice president and chairman of Section N—Medical Sciences: S. E. Luria, professor of bacteriology, University of Illinois.

Vice president and chairman of Section P—Industrial Science: Earle L. Rauber, vice president and

director of research, Federal Reserve Bank, Atlanta.

The following section secretaries were appointed:

Section E—Geology and Geography: Robert L. Nichols, Henry Bromfield-Pearson professor of natural science and geology, Tufts College.

Section L—History and Philosophy of Science: Jane M. Oppenheimer, professor of biology, Bryn Mawr College.

Further Section Reports of the Berkeley Meeting

The following reports were received too late for the Proceedings Issue [*Science* 121, 255–266 (1955)]:

Section on Botanical Sciences (G)

The program of Section G at the Berkeley meeting featured symposiums dealing with topics of broad significance to botanists and biologists generally. The section sponsored an outstanding symposium, *Modern Views on Tissue Differentiation*, arranged by Adriance S. Foster, and cosponsored five other excellent symposiums, arranged by participating societies, on structural differentiation in the fungi, the cell, the harnessing of biological resources, the marking of organisms for ecological studies, and photochemical effects in biological and biochemical systems. The wide scope of the fields covered by these symposiums is evidence of the success that the section met in its effort to provide programs of broad interest to botanists. All sessions attracted large audiences and were frequently marked by a lively level of discussion. Of particular interest to botanists was the symposium on tissue differentiation. As a result of careful planning by Foster, the symposium provided an excellent summary of this important and often neglected subject. An additional session was devoted to contributed papers.

One of the highlights of the meeting was the traditional botanists' dinner, attended by more than 200 botanists. It was the occasion of a notable talk on the status of natural resources by our retiring chairman, Stanley A. Cain, and of the presentation of the Mary Soper Pope medal of the Cranbrook Institute of Science to I. W. Bailey.

The friendly hospitality of the Berkeley Botany Department contributed a great deal to the success of the Section G meeting. The Department thoughtfully provided a headquarters room that offered a pleasant refuge for foot-weary botanists and an opportunity for the informal chats that are such an important feature of a meeting. The section would do well to continue this innovation at future meetings.

Plans for the Atlanta meeting are now being developed. All members of the Section are invited to communicate with the secretary concerning suggestions for the program of our 1955 meeting.

BARRY COMMONER, *Secretary*

Section on the History and Philosophy of Science (L)

A feature of the section program on the history and philosophy of science was an exhibit of classic contributions to science arranged in the University of California Library. This exhibit was prepared by members of the Herbert M. Evans history of science seminar at the University of California.

An outstanding feature of the section program was a symposium on probability and induction, which was cosponsored with the section on mathematics arranged by Edward W. Barankin (University of California), Patric C. Suppes (Stanford University), C. West Churchman (Case Institute of Technology), and William R. Dennes (University of California). This symposium was part of the *Third Berkeley Symposium on Mathematical Statistics and Probability*. Factors concerning value judgments in science comprised a considerable portion of the symposium.

Historical papers for the section were given by Richard A. Fayran (University of California) on the history of engineering, by J. B. deC. M. Saunders (University of California) on the anatomy of Leonardo da Vinci, by J. M. D. Olmsted (University of California) on French contributions to physiology in the 19th century, and by William Gibson (University of British Columbia) on scientific contributions of medical students. Frederick Koenig (Stanford University) presented an interesting discussion of the work of Sadi Carnot.

The philosophical contributions to the section ranged widely. Egon Brunswik (University of California) gave an important discussion on the relationship of psychology to other sciences. Michael Scriven (University of Minnesota) discussed factors involved in scientific explanation. Joseph Mayer (Miami University, Ohio) and Jerome R. Head (University of Chicago) discussed general philosophical implications of current scientific problems. Patrick Romanell (University of Texas Medical Branch) described the scientific implications of 20th century Italian philosophy.

The chairman's address was given by Chauncey D. Leake (University of Texas Medical Branch) on "The ideals of science in relation to national security." The section endorsed the statement on security prepared by the Board of Directors of the AAAS. Raymond Seeger was nominated as chairman of the section.

An interesting feature of the section meeting was a luncheon held at the Shattuck Hotel at which there was general discussion on the philosophical aspects of the history of science.

CHAUNCEY D. LEAKE, *Vice President and Chairman*

To succeed in science it is necessary to receive the tradition of those who have gone before us. In science, more perhaps than in any other study, the dead and the living are one.—CHARLES SINGER.

Frobisher - Microbiology

The aim of this book is to give the college student a broad familiarity with microorganisms—and the many vital roles they play in the world today. The student is introduced to the highly diverse aspects of this field in an orderly, progressive manner.

The book is divided into five sections dealing with the relations of microorganisms to each other and to the living world; methods and phenomena of microbiology; immunology; the bacteria as a class; and the microbiology of special environments. Especially notable is the material on the physiology, genetics and metabolism of microorganisms. Bibliographies contain pertinent references to aid further study, and there are hundreds of helpful illustrations.

By Martin Frobisher, Jr., ScD., Special Consultant, Bacteriology Branch, Communicable Disease Center, U. S. Public Health Service, Chamblee, Georgia; Associate Professor of Bacteriology, Emory University; Visiting Lecturer, Johns Hopkins University School of Hygiene and Public Health. 633 pages, 6⅛" x 9¼", with 253 illustrations. $6.00. *Fifth Edition.*

Villee - Biology

In presenting *elementary general biology*, the author has selected a careful course between superficiality and oversimplification on the one hand, and over-complication on the other. The student is given all the information he *should* acquire in a college course in biology—but he isn't overloaded with facts beyond his understanding.

The fashion in which the subject is developed is masterly. Methods of scientific investigation are first discussed. Part I is on cell structures and functions. Biologic interrelationships, plant evolution, etc. are covered in Part II, while Part III is devoted to lower and higher invertebrates and the phylum Chordata. Part IV discusses the various systems of the body, and Part V, the reproductive process. The last three parts consider heredity and genetics, evolution, and ecology.

By Claude A. Villee, Jr., Ph.D., Instructor in Biological Chemistry, Harvard Medical School. 670 pages, 6" x 9", with 293 illustrations. $6.50. *Second Edition.*

W. B. SAUNDERS COMPANY

West Washington Square, Philadelphia 5

INTERNATIONAL ARID LANDS MEETINGS

of the AAAS and its

SOUTHWESTERN AND ROCKY MOUNTAIN DIVISION

University of New Mexico, Albuquerque, New Mexico, April 26-29

Southwestern Field Trip, Albuquerque-El Paso and return, April 30-May 1

Featuring a **Symposium on What is the Future of Arid Lands?** Public evening lectures, April 26, 27 and 28 by Homer L. Shantz, Charles E. Kellogg, and B. T. Dickson (Australia), and Technical Sessions:

Morning, April 27—Variability and Predictability of Water Supply in Arid Regions—Speakers: Reed W. Bailey, C. W. Thornthwaite, Jean Tixeront (Tunisia), Luna Leopold, F. Dixey (England), C. C. Wallén (Sweden), John H. Dorroh, T. L. Smiley.

Afternoon, April 27—Better Use of Present Resources—Speakers: Kanwar Sain (India), R. O. Whyte (Italy), L. N. McClellan, Hilgard O'R. Sternberg (Brazil), L. A. Richards, Cyril Luker, Raymond Price, Pedro Armillas (Mexico).

Morning, April 28—Prospects for Additional Water Sources—Speakers: E. J. Workman, Edward Bowen (Australia), Sheppard T. Powell, W. F. J. M. Krul (Holland), Vincent J. Shaefer, Glenn W. Brier, H. E. Hayward, Louis Koenig.

Afternoon, April 28—Better Adaptation of Plants and Animals to Arid Conditions—Speakers: Olaf S. Aamodt, Colonel Omar Draz (Egypt), R. Merton Love, Knut Schmidt-Nielsen, Enrique Beltrán (Mexico), B. P. Uvarov (England), Michael Evenari (Israel), L. M. Pultz.

Discussion Group Sessions, April 29 (See SCIENCE of February 11, 1955, or THE SCIENTIFIC MONTHLY of March, 1955, or write to the American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., U.S.A., for details. Cable Address: Advancesci, Washington, D. C.)

Housing Reservation

International Arid Lands Meetings Housing Bureau
Chamber of Commerce, Albuquerque, New Mexico

Please send requests *directly* to the Bureau to save time. Confirmation in two weeks in order received. *Single rooms may become scarce; if possible share a twin-bedded room—and also save.* Be sure to indicate if you need a room the night of May 1 on return from the Field Trip. *Deadline for receipt of reservations,* **April 15.**

Hotels	*Single with bath*	*Double with bath*	*Twin-bedded with bath*
HILTON	$7.50	$9.00	$10.00
FRANCISCAN	5.50	6.60	9.50
ALVARADO	5.50–9.00 (only a few 5.50)	.....	8.50–12.00
EL FIDEL	4.50 (a few 3.50 & 4.00 without bath)	5.00–6.00 (a few 3.50 & 4.50 without bath)	8.00 (a few 5.00 & 7.00 without bath)
Motels (all with bath)	$4.00–$5.00	$5.00–$6.00	$7.00–$10.00

All of the above prices subject to 2% state tax.

Please reserve the following accommodations: Date of Application: .....
State name of hotel or insert "Motel" if this is your preference:
First Choice ..... Second Choice ..... Third Choice .....

.....Single room with bath Desired rate ..... Maximum rate .....
.....Double-bedded room with bath Desired rate ..... Maximum rate .....
.....Twin-bedded room with bath Desired rate ..... Maximum rate .....

The name and address of each person, including yourself, must be listed (attach list if necessary.) .....

.....

Date and time of arrival ..... Date and time of departure .....

Mode of Transportation .....

Name .....
(Please print or type name of individual making this request.)

Address .....
(Street) (City and Zone) (State)

Enclose deposit of $10.00 (refunded if cancelled before **April 15.**)
Make checks payable to Berl Huffman, Secretary, Albuquerque Chamber of Commerce.

Registration Form

International Arid Lands Meetings
(*All Registration by Mail in Advance. No fee.*)

Name (Dr., Miss, etc.) .....
(Please print or type) (Last) (First) (Initial)

Academic, Professional or Business Connection and Title .....

Office or Home Address (Mail Address) .....

.....

Field of Interest .....

Probable Discussion Group Preference (by number) .....
(*You will be free to change or to attend more than one.*)

Field Trip Reservation (limited to first 222 applicants—deadline **April 5**)
Yes ..... No ..... ($20.00 for trip, lodging, and meals *must* accompany reservation. Refunds up to April 15.)

Send to: Dr. E. F. Castetter, University of New Mexico, Albuquerque, New Mexico, U. S. A.

Martin's

INDUSTRIAL & MANUFACTURING CHEMISTRY

A Thoroughly Revised Edition in 3 Volumes

A continued demand for Martin's "Industrial Chemistry" over the past twenty years has resulted in the publication of this new edition. A new Editor has been appointed, with instructions to bring the work up to date without altering its essential character.

In order to do this in a satisfactory manner, all out-of-date matter without historical or technical significance has been replaced by new matter, but the older material relating to the classical development of processes or industries has been retained because of its great value to students, manufacturers, and commercial interests. The sections on fuel and related processes have been re-written completely, and complementary new sections added to cater for the increasing world awareness of the importance of fuel economy and to illustrate the great advances in the subject of fuel utilization and power generation that have taken place during the past few decades.

In other major sections, sufficient new material has been included to indicate the latest developments in the various subjects and numerous references to new books and to the periodic scientific literature have been given to enable the specialized reader to obtain more details of the latest information on any subject than it has been possible to provide in the space available. This has meant, in some instances, making the larger sections a little unwieldly, though up to date. Many of the minor sections have been enlarged to include recent developments and in all cases up-to-date references are given.

Part I—ORGANIC *(One Volume, nearly 800 pages)*

Seventh Edition Revised (1952) under the General Editorship of EDWARD I. COOKE

TABLE OF CONTENTS

The Oil, Fat, Varnish, and Soap Industry—The Sugar Industry—The Starch Industry—The Cellulose Industry—Fermentation Industries—The Charcoal and Wood-Distilling Industries—The Turpentine and Rosin Industry—Industrial Gums and Resins—The Rubber Industry—The Industry of Aliphatic Chemicals—The Fuel Gas Industry—Industry of Coal Tar and Coal Tar Products—Industry of the Synthetic Coloring Matters—The Industry of Natural Dyestuffs—The Ink Industry—The Paint and Pigment Industry—Textile Fibre, Bleaching, and Waterproofing Industries—The Dyeing and Color Printing Industry—The Leather and Tanning Industry—Glue, Gelatine, and Albumen Industry—The Industry of Modern Synthetic and other Drugs—The Plastics Industry—The Industry of Photographic Chemicals—The Tobacco Industry—Index.

Part II—INORGANIC *(Two Volumes, nearly 1200 pages)*

Sixth Edition Revised (1954) under the General Editorship of WILFRID FRANCIS

SUMMARY OF VOLUME 1

Solid Fuels—Manufacture of Briquettes—Liquid Fuels—Furnaces—Coke Ovens—Surface Combustion—Pyrometry and Pyroscopy—Refrigerating and Ice-Making—Liquefaction of Gases—Industrial Oxygen, Nitrogen, and Hydrogen—Producer Gas—Carbon Dioxide and Carbonic Acid—Industrial Ozone—Technology of Water—Artificial Mineral Waters—Sulphur, Sulphuric Acid, Sulphur Dioxide and Sulphites—Salts—Hydrochloric Acid—Sodium Sulphate, Sodium Carbonate, and Soda—The Stassfurt Industry—Potassium Salts—Calcium and Magnesium Salts—Gypsum—Barium Salts—Strontium Salts—Compounds of Boron—Manufacture of Chlorine—Electrolytic Chlorine and Alkali—Liquid Chlorine—Chlorates and Perchlorates—Bleaching Powder—Bromine—Iodine—Hydrofluoric Acid—Peroxides and Per-Acids—The Nitrate Industry—Nitric Acid—Ammonia and Ammonium Salts—Synthetic Ammonia—The Cyanamide Industry—The Cyanide and Prussiate Industry—Nitrous Oxide—Index.

SUMMARY OF VOLUME 2

Disinfectants and Antiseptics—Artificial Manures—Insecticides, Etc.—Aluminium Compounds—Artificial Zeolite or Permutite—Artificial Gems—Thermic Reactions—Calcareous Cement—Sorel Cement—Artificial Stone—Sodium Silicate, Water Glass and Soluble Glass—Lutes and Miscellaneous Cements—Clays and Allied Materials—Pottery—Earthenware—Porcelain—Stoneware—Bricks—Tiles—Furnace Linings—Glass—Enamels—Asbestos—Mica—Thorium and Cerium—Titanium—Zirconium—Tantalum—Tungsten—Incandescent Glow Lamps—Industry of Radio-Active Materials—Electric Furnace Products—Compositions for Grinding and Polishing—Phosphorus—Matches—Index.

ALL VOLUMES BUCKRAM BOUND AND PROFUSELY ILLUSTRATED

Please check volumes desired and enclose remittance to expedite shipment.

☐ All Three Volumes $50.00 ☐ Organic $17.50 ☐ Inorganic Vol. 1 $17.50 ☐ Inorganic Vol. 2 $17.50

PHILOSOPHICAL LIBRARY, *Publishers* 15 East 40th St., Desk Z, N. Y. 16, N. Y.

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D. C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1; Canadian postage, 50¢.

Astronomers — Physicists — Electronic Engineers

ASTRONOMICAL PHOTOELECTRIC PHOTOMETRY

Edited by

Frank Bradshaw Wood

Flower and Cook Observatories, University of Pennsylvania

6 x 9 inches, 141 pages, 40 illustrations, clothbound

Price $3.75 Special price to AAAS members $3.25

The papers in this symposium, presented in somewhat abbreviated form at the AAAS Meeting in Philadelphia, will help those wishing to enter this field, especially in the design and construction of equipment. The material—and the bibliography included with the first paper—will also prove invaluable to those actively working in the field. Although the number of contributors is limited, the papers cover developments around the world.

Dr. Linnell, who covers direct current techniques, constructed a photoelectric photometer still in use at the Boyden station in South Africa, and while at Harvard used this in the study of the faint and unusual eclipsing variable, UX Ursae Majoris. His present work involves the development of techniques using subminiature tubes.

Dr. Hall—alternating current techniques—is co-discoverer of the phenomenon of the polarization of the light of certain stars, and was the first astronomer to demonstrate the value of refrigeration of photocells.

Dr. Blitzstein constructed the first pulse-counting photometer for astronomical use and applied it to the observation of eclipsing variables.

Although Dr. Bengt Stromgren of the Yerkes and McDonald Observatories reviewed foreign developments at the Philadelphia meeting, this volume includes papers written by MM. Lellemand and Lenouvel on work at the Observatoire de Haute Provence and by R. O. Redman, Director, and G. G. Yates of the Observatory at Cambridge University.

Dr. Walraven of Leiden describes the work with servomechanisms carried out by him at the Union Observatory in Johannesburg.

Dr. Whitford, who supplies the critical summary and evaluation of future developments, has been considered an outstanding authority in this field for many years. His introduction of the constant deflection method using electrometer tube techniques marked a major advance.

TABLE OF CONTENTS

The Use of Direct-Current Techniques in Photoelectric Photometry of Stars—Albert P. Linnell, Amherst College Observatory—1. Alternating-Current Techniques and Sources of Error in Photoelectric Photometry of Stars—John S. Hall, The Equatorial Section of the U. S. Naval Observatory—41. The Use of Pulse-Counting Techniques in Photoelectric Photometry of Stars—William Blitzstein, Flower and Cook Observatories, University of Pennsylvania—64. Photoelectric Installation of the Observatoire de Haute Provence, A. Lallemand, Observatoire de Paris —88. Photoelectric Installation at the Observatoire de Haute Provence, F. Lenouvel, Observatoire de Haute Provence, St. Michel, Basses Alpes, France—89. The Performance of Two Pulse-Counting Stellar Photometers, R. O. Redman and G. G. Yates, Cambridge University Observatory—93. On the Use of Servomechanisms in Photoelectric Photometry of Stars, Th. Walraven, Leiden Observatory, Southern Station, Johannesburg—114. Limits of Sensitivity and Precision Attainable by Photoelectric Methods, Critical Summary and Comparison of Various Techniques, A. E. Whitford, Washburn Observatory, University of Wisconsin—126.

TO: AAAS PUBLICATIONS
1515 Mass. Ave., N.W., Washington 5, D. C.
Please accept my order for ..... copy of ASTRONOMICAL PHOTOELECTRIC PHOTOMETRY. Check for $..... is enclosed.

Name .....
Address .....
City ..... Zone .... State .....

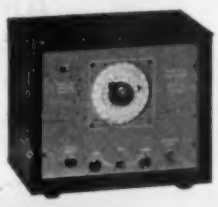
Packard

AUTOMATIC FRACTION COLLECTOR

Provides Both Time and Drop Counting Operation For the Most Precise Fraction Cutting Requirements of Chromatographic Work

- Drops from column fall directly into test tube. No intermediate glass arms or funnels—possibility of mixing, contamination or evaporation is eliminated. This is especially important where accurate separations are required or where certain fractions are labeled with radioactive tracers.
- Any number of drops from 1 to 400 can be collected in each tube for drop counting. Any time interval from ¼ to 100 minutes in ¼-minute steps can be selected for time operation.
- Turntable can be indexed by means of "Manual Index" switch for convenience in setting up experiments.
- All principle parts—turntable, phototube housing, etc.—are made of stainless steel.

Price complete for time and drop counting **$795.00**
Price for time operation only **$535.00**



Send for complete information today

•

Packard Instrument Company
Dept. A., P.O. Box 428
LaGrange, Ill.

OROTIC ACID

(Uracil-6-carboxylic acid)

highly specific precursor of nucleic acid pyrimidines in algae, bacteria and mammals. Growth factor for mice, rats, chicks, pigs, tumors and bacteria (*L. casei* and *L. bulgaricus*). Present in milk. May be a moiety of Vitamin B_{12} (unknown growth factor in distiller's dried solubles).

AVAILABLE

in laboratory and commercial lots. Inquiries solicited from the headquarters for and custom manufacturers of high-quality purines, pyrimidines and amino acids.

H. M. CHEMICAL CO.
1651 - 18th St. Santa Monica
California

SCIENCE - 1954 ON MICROCARDS

The response to the Microcard edition has encouraged us to make volumes 119 and 120 of SCIENCE available in this form.

Eighty-three 3" x 5" cards contain all 3,192 pages of SCIENCE for the year 1954.

The space saving is considerable. 25 sets of Microcards take up approximately the same space as a single bound volume of SCIENCE covering the same period. The bother and expense of binding is completely eliminated. In spite of a 19% increase in volume, the price remains unchanged:

Microcard edition of SCIENCE, 1953 $15.00
" " of SCIENCE, 1954 $15.00

AAAS
1515 Mass. Ave., N.W.
Washington 5, D. C.

NOW OVER **5100** CHEMICALS

BIOS

- Calcium Arabonate
- Calcium Arsenite
- Calcium Borate
- Calcium Bromolactobionate
- Calcium Fluotitanate
- Calcium Fluozirconate
- Calcium Glycocholate
- Calcium Malate
- Calcium Metaborate
- Calcium α-Naphthylphosphate
- Calcium Sucrate
- Calcium Undecylenate
- Camphoquinone
- Camphor Salicylate
- Camphylamine
- Cantharidin
- p-Carbamyl-phenylsarsine Oxide
- Carbobenzoxy-1-glutamyl-1-tyrosine
- Carboxybenzenesulfonamide
- p-Carboxy-phenylarsinoxide
- 5-Carboxyuracil (Uracil-5-carboxylic acid)
- Carnaubic Acid
- Carnaubyl Alcohol
- Caronamide
- Carrageenic Acid
- Carrageenin
- Caryophylline
- Cellotriose
- Cellulase
- Cerium Fluoride
- Cerium Metal
- Cerotic Acid
- Cetyldimethylamine
- Chelidamic Acid

Ask for our new complete catalogue

BIOS *Laboratories Inc.*

17 West 60th St. New York 23, N. Y.
Fl... 7 8171

AERODYNAMICS · ASTRONOMY · BUSINESS & ECONOMICS · CHEMISTRY · COMMUNICATION · ELECTRONICS · ENGINEERING · MANAGEMENT · MATHEMATICS · MEDICINE · MINEROLOGY

A unique book service

For institutional and industrial libraries and research personnel

Scientific and Technical books of all publishers supplied on approval. No cost—no obligation—free postage. If a book does not suit your needs return it for full credit.

TECHNICAL BOOKS OF AMERICA

A leading supplier of books to commerce and industry

For more information and free catalogues and bulletins write today on your company letterhead to Technical Books of America, Box #312, subsidiary of

THE SCRIBNER BOOK STORE,
597 Fifth Ave., N. Y. 17, N. Y.

KLETT ELECTROPHORESIS

CUSTOM MADE

TOOL FOR THE ANALYSIS OF COMPLEX COLLOID SYSTEMS, AND FOR THE CONTROL OF PRODUCTION OF PURIFIED PROTEINS, ENZYMES, HORMONES

KLETT MANUFACTURING CO.
179 EAST 87TH STREET
NEW YORK, N. Y.

AAAS EDITORIAL BOARD

Dael Wolfle
Acting Editor

Charlotte V. Meeting
Assistant Editor

Mark H. Adams
William R. Amberson
Wallace R. Brode
William L. Straus, Jr.
Bentley Glass
Karl Lark-Horovitz
Edwin M. Lerner

Advertising Representative: F. A. Moulton

National Association of Boards of Pharmacy

A New Associate Society of the AAAS

ORGANIZATION of the National Association of Boards of Pharmacy was effected in 1904 at a meeting of representatives of the pharmacy licensing boards of 26 states. This first meeting was held in conjunction with the annual meetings of the American Pharmaceutical Association. The present active membership is composed of the boards of pharmacy or licensing bodies of 45 states, the District of Columbia, Alaska, and Puerto Rico. The boards of pharmacy in California, Florida, and New York are associate members.

The objective of the association, declared in the constitution, is to provide for interstate reciprocity in pharmaceutic licensure, based upon a uniform minimum standard of pharmaceutic education and uniform legislation; and to improve the standards of education and licensure by cooperating with state, national and international agencies and associations having similar objectives.

The association constitutes a forum of the examining boards for the discussion of examination techniques, procedures, and all other subjects that are designed to raise the standards of pharmaceutic education and predicates registration upon the highest practical legal qualifications. The several states are grouped into districts, which are known as N.A.B.P. Districts wherein district meetings of the boards of pharmacy and faculties of the colleges of pharmacy have been fostered as a matter of expediency. Important and informative compilations have been prepared and published, and the association maintains a file record of all state pharmacy laws, interpretations and legal opinions of record pertaining to requirements and qualifications for licensure, and also the regulations adopted by the state boards of pharmacy. It has endeavored to compile annually licensure and census data to indicate by states the number of licensed persons engaged in pharmacy, how engaged, number licensed, and number of pharmacies in operation, and, as a service to the membership, to disseminate this information along with other current information related to the education and licensure of pharmacists, examination procedures, trends in education and legislation pertaining to pharmacy licensure requirements. This material is to be found in the *Proceedings*, which has been published annually since the association was founded, and in the *N.A.B.P. Bulletin*, a bimonthly publication. Examiners or board members frequently change, and new appointees call upon the association for information by which to be guided and aided

Recommendations made by the association with respect to subjects, scope, and length of the examinations that are given to applicants for licensure in all states have been accepted by the membership and have fostered a degree of uniformity in licensing procedure. The establishment of uniformly high legal requirements or qualifications that applicants for licensure in all states must possess is due largely to the program of action that has been carried out by the N.A.B.P. to secure such qualifications and make reciprocal licensure more feasible

Within the framework of this organization acceptable uniform procedures have been established and necessary forms on which to furnish the required data concerning age, citizenship, education, training, examination record, license number, date of license, character, and practice, together with instructions to complete and file the same as a formal and acceptable application to be licensed by reciprocity, are made available to pharmacists who wish to acquire a license in this manner.

The association does not speak for, or commit any of, its members who must act upon the applications, but the service facilitates and expedites the prompt completion of applications in complete detail, which is a matter of importance when the urgent needs of an employer, an employee, or a community for pharmaceutical service are concerned.

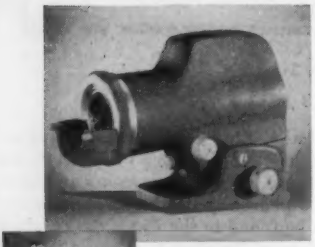
P. H. COSTELLO, *Secretary*
National Association of Boards of Pharmacy

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa.
SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.
All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D. C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

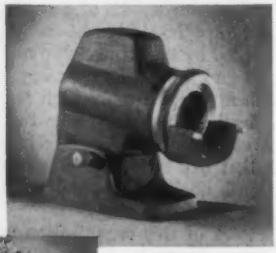
Change of address: The notification should reach us four weeks in advance. If possible, please furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including postal zone numbers, if any.
Annual subscriptions: $7.50; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, 50¢. Single copies 25¢. Special rates to members of the AAAS. Cable address: Advancesci Washington.
The AAAS also publishes THE SCIENTIFIC MONTHLY.

NEW LIGHT

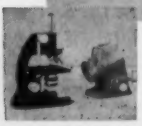
for easier, more efficient microscopy



Model PR-27 • For critical research visual observation and photomicrography. Automatic focusing.



Model PG-26 • For all visual observations and photomicrography. High intensity; quick focusing.



Model PL-25 • For general visual use. Low cost; full field illumination; no focusing needed.

PROFESSIONAL TYPE

MICROSCOPE ILLUMINATORS

Whatever your microscopy requirements—from general observation to critical research, visual or photomicrographic—one of these 3 new illuminators will save you time and ensure you the bright, easy-to-see images you need.

- **Sets to desired angle in seconds—*stays* set.**
- **Comfortable to the touch, even after hours of use.**
- **Easy on your eyes, too: no stray light, no glare.**
- **Lamp is replaced in seconds . . . *automatically centered!***
- **Dustproof, trouble-free construction.**
- **Sturdy, well balanced—no tip-over.**

WRITE FOR DETAILED LITERATURE • Ask for Folder D-1042. Bausch & Lomb Optical Co., 64262 St. Paul St., Rochester 2, N. Y.

BAUSCH & LOMB

SINCE B&L 1853

America's only complete optical source... from glass to finished product.

MORE CONTRAST

Announcing the

"ANOPTRAL"

PHASE CONTRAST EQUIPMENT

by Reichert-Wilska

A new method of light microscopy to achieve

- Far greater Contrast than ordinary Phase
- Optimum Resolving Power
- Elimination of Stray Light

The Anoptral Phase Contrast Equipment consists of four special objectives, a condenser of high numerical aperture and auxiliary microscope and can be employed with most standard microscopes.

WILLIAM J. HACKER & CO., INC.
82 BEAVER ST., NEW YORK 5, N. Y.

Linde
Trade-Mark

M. S. C.
(Mass Spectrometer Checked)
RARE GASES

HELIUM · NEON · ARGON · KRYPTON · XENON

LINDE Rare Gases are mass spectrometer checked to assure you gases of known purity and uniformly high quality. Available in commercial-size cylinders and glass bulbs.

LINDE, the world's largest producers of gases derived from the atmosphere, can meet your individual needs of purity . . . volume . . . mixtures . . . containers . . .

LINDE AIR PRODUCTS COMPANY
A DIVISION OF
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street UCC New York 17, N. Y.
In Canada: Dominion Oxygen Company, Limited, Toronto

The term "Linde" is a registered trade mark of Union Carbide and Carbon Corporation.

CANCER the subject of outstanding A. A. A. S. Symposium Volumes:

Some Fundamental Aspects of the Cancer Problem, 1937, Out of print.

MAMMARY TUMORS IN MICE, 1945:

10 contributors, VIII + 223 pages, 7½ × 10½, clothbound, double column, illustrated, $3.50. Cash order price to A.A.A.S. members $3.00.

. . . Coordinated knowledge of cancer of the breast in mice.
. . . It cannot fail to stimulate interest and further research efforts in one of our most fascinating and important biological problems.
. . . Prepared by members of the staff of the National Cancer Institute.

A.A.A.S. Research Conference on Cancer, 1945, Out of print.

APPROACHES TO TUMOR CHEMOTHERAPY, 1947:

93 contributors, X + 442 pages, 7½ × 10½, clothbound, double column, illustrated, $7.75. Cash order price to A.A.A.S. members $6.50.

. . . A progress report, addressed largely to future workers.
. . . An important and trustworthy reference book.
. . . Planned under the auspices of National Cancer Institute, Memorial Hospital of New York, Sloan-Kettering Institute for Cancer Research, Lankenau Institute of Philadelphia, and others.

ORDER NOW

TO: AAAS, 1515 Mass. Ave., N.W.
Washington 5, D. C.

Enclosed is $..... Please accept my order for
☐ MAMMARY TUMORS in MICE
☐ APPROACHES to TUMOR CHEMOTHERAPY

Name .....
Address .....
City ..... Zone ..... State .....

Outstanding

McGRAW-HILL BOOKS

ELEMENTS OF ASTRONOMY New 5th Edition

By EDWARD ARTHUR FATH, Formerly Professor of Astronomy and Director of the Observatory, Carleton College. 396 pages, $5.50

This highly successful text for a brief introductory course covers the whole range of the science of astronomy. Revised and contemporized to take account of new observational material and new ideas which have been developed since the publication of the previous edition. The author has sought to include every important discovery published up to the time of going to press. A new chapter on Interstellar Matter has been added, and many new illustrations included.

DIELECTRIC BEHAVIOR AND STRUCTURE

By CHARLES P. SMYTH, Princeton University. *International Chemical Series.* Ready in April

A specialized book explaining the relations between the molecular structure of matter and the dielectric behavior of matter. It considers the interpretation of dielectric constant and loss data in terms of structure, and actual methods of measurement. The book also provides the most extensive available account of the use of dipole moment in the determination of molecular structure and in the study of the nature of the chemical bond and resonance. This work is important in the chemistry, physics, and engineering of insulators of all types, and also significant in the study of organic molecules.

PRACTICAL PHYSICS New Second Edition

By MARSH W. WHITE, KENNETH V. MANNING, and ROBERT L. WEBER, Pennsylvania State University. 496 pages, $5.50

A concise textbook including all the topics basic to the science of general physics. The choice and arrangement of topics is skillfully designed to utilize in a progressive manner the simple mathematics which the student is taking concurrently. Heat and fluids are discussed before the mechanics of solids. Sound, electricity, and light follow in order. New chapters on Color, Modern Atomic Physics, and Nuclear Physics have been added. Simple, direct, explanations and solved numerical examples inculcate correct thinking and understanding. Correlated with each chapter are simple experiments designed to complement the theory material.

INTRODUCTORY APPLIED PHYSICS

By NORMAN C. HARRIS, and EDWIN M. HEMMERLING, Bakersfield College. 744 pages, $6.75

Provides the groundwork leading to an understanding of technical problems met in industry. Physics is presented as an indispensable tool, and emphasis is placed on present-day applications. Concept and practice are fused so that the student can readily relate what he has learned from the text to the demands he will meet on the job. The book covers mechanics, heat, sound, light, magnetism and electricity, electronics, and a brief introduction to atomic physics.

SEND FOR COPIES ON APPROVAL.

McGRAW-HILL BOOK COMPANY, Inc.

330 West 42nd Street • New York 36, N. Y.

Meetings & Conferences

May

1–3. American Assoc. of Colleges of Pharmacy, Miami, Fla. (R. A. Deno, College of Pharmacy, Univ. of Michigan, Ann Arbor.)

1–3. American Soc. of Hospital Pharmacists, Miami Beach, Fla. (G. Neimeyer, 2215 Constitution Ave., NW, Washington, D.C.)

1–4. American Institute of Chemical Engineers, Houston, Texas. (S. L. Tyler, AICE, 120 E. 41 St., New York 17.)

1–5. Electrochemical Soc., Cincinnati, Ohio. (H. B. Linford, 216 W. 102 St., New York 25.)

2–4. American Geophysical Union, annual, Washington, D.C. (W. E. Smith, AGU, 1530 P St., NW, Washington 5.)

2–4. Research Equipment Exhibit and Symposium in Instrument Techniques and Applications, annual, National Institutes of Health, Bethesda, Md. (J. B. Davis, Supply Management Branch, NIH, Bethesda 14.)

4–5. American Psychosomatic Soc., 12th annual, Atlantic City, N.J. (L. S. Kubie, APS, 551 Madison Ave., New York 22.)

4–6. American Inst. of Electrical Engineers (Middle Eastern District), Columbus, Ohio. (N. S. Hibshem, AIEE, 33 W. 39 St., New York 18.)

4–6. American Meteorological Soc., Washington, D.C. (K. C. Spengler, A.M.S., 3 Joy St., Boston 8, Mass.)

5–6. Soc. of American Military Engineers, 35th annual, New York, N.Y. (F. H. Kohloss, SAME, Mills Bldg., 17th at Pennsylvania Ave. NW, Washington 6.)

5–7. American Ethnological Soc., Bloomington, Ind. (Alice G. James, Hunter College, 695 Park Ave., New York 21.)

5–7. Kansas Acad. of Science, Lawrence. (C. T. Rogerson, Dept. of Botany, Kansas State College, Manhattan.)

5–7. Illinois State Acad. of Science, Carbondale. (L. E. Bamber, ISAS, 223 Natural History Bldg., Urbana, Ill.)

5–7. Soc. for American Archaeology, Bloomington, Ind. (G. I. Quimby, Chicago Natural History Museum, Chicago 5, Ill.)

5–7. Soc. for Applied Anthropology, Bloomington, Ind. (E. Purcell, SAA, 61 W. 55 St., New York 19.)

6. American Assoc. of Spectrographers, 6th annual, Chicago, Ill. (F. E. Stedman, Engineering Research Laboratory, Bendix Aviation Corp., 401 N. Bendix Dr., South Bend 20, Ind.)

6. Conference for Engineers, 2nd annual, Columbus, Ohio. (H. A. Bolz, College of Engineering, Ohio State Univ., Columbus.)

6–7. Illinois Acad. of Science, annual, Carbondale. (L. E. Bamber, 233 Natural History, Univ. of Illinois, Urbana.)

6–7. North Carolina Acad. of Science, annual, Davidson, N.C. (J. A. Yarbrough, Meredith College, Raleigh, N.C.)

6–7. North Dakota Acad. of Science, annual, Grand Forks, N.D. (J. Donald Henderson, University Station, Grand Forks.)

6–7. South Dakota Acad. of Science, Brookings. (A. L. Haines, Chemistry Dept., Univ. of South Dakota, Vermillion.)

6–8. American Psychoanalytic Assoc., Atlantic City, N.J. (R. L. Frank, 745 5 Ave., New York 22.)

(See issue of 18 March for more comprehensive listings.)

GARCEAU ELECTROENCEPHALOGRAPHS

A.C. Operated — **No Batteries**
Inkless Writing — **Require no Shielding**
Shipped Ready to Run — **Prompt Delivery**

THE JUNIOR GARCEAU
ELECTROENCEPHALOGRAPH

A simplified inexpensive instrument for recording electrical potentials of the brain. Built-in interference eliminators permit use anywhere. Inkless records—no photography or film-development required. Instantaneous localization with any 2 of the 10 leads. Price $575.00 complete.

All Garceau Electroencephalographs operate entirely from the 115 volts 50 or 60 cycle power lines.

ELECTRO-MEDICAL LABORATORY, INC.
SOUTH WOODSTOCK 2, VERMONT

Crystalline
Enzymes and Biochemicals

DESOXYRIBONUCLEASE
TRYPSIN

SOYBEAN TRYPSIN INHIBITOR

Ribonuclease — Chymotrypsin
Alcohol dehydrogenase
Phosphatase — Carboxypeptidase
Hyaluronidase — Ovalbumin
and many others

write for current catalog

WORTHINGTON BIOCHEMICAL CORP.
Freehold, New Jersey

7X®

Used by Leading Laboratories for Cleaning All Types of Laboratory Glassware

NON-TOXIC for TISSUE CULTURE

At Less Than 3¢ Per Gallon

7X is a concentrated liquid that can be diluted and is instantly and completely soluble. 7X rinses and drains completely, quickly; does not leave a film. It can be used over and over.

Also Used by Leading Hospitals, Clinics & Health Depts.

WRITE FOR COMPLETE INFORMATION

LINBRO CHEMICAL CO.
681 DIXWELL AVE., NEW HAVEN 11, CONN.

NEW MICROPIPETTE PULLER

***Fully Automatic*—easily operated by laboratory assistants.**

Complete in *One Unit*
Developed and tested in active laboratories
Magnetic Principle—Two stage
Adjustable over wide range of operation

—Soft or Hard tubing
—Tubing 0.5 mm. to 2 mm. O.D.
—Variable heating and pulling cycles
—Pipette tips can be produced in a variety of lengths and tapers.
—Easily produces pipettes with less than 0.5 mμ O.D. tip.

Price complete F.O.B. N.Y.C. $300.00

INDUSTRIAL SCIENCE
63-15 Forest Avenue
Ridgewood 27, N. Y.

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries — at a very low cost

CLASSIFIED: 18¢ per word, minimum charge $3.60. Use of Box Number counts as 10 additional words.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis —provided that satisfactory credit is established.

Single insertion	**$19.50 per inch**
7 times in 1 year	**17.50 per inch**
13 times in 1 year	**16.00 per inch**
26 times in 1 year	**14.00 per inch**
52 times in 1 year	**12.50 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

POSITIONS WANTED

Bacteriologist–Immunologist with wide experience wishes position. Academic, research or industrial. Box 104, SCIENCE. X

Bacteriologist, Ph.D., wants summer employment—West Coast or Rockies. Box 77, SCIENCE. 4/8

Bacteriologist, Ph.D. medical, general. Desires summer employment, teaching or industrial. Box 93, SCIENCE. X

Biologist, Ph.D., 34, ecology, invertebrates, ornithology, evolution; has taught elementary botany; desires change in teaching position with opportunity to continue research. Box 101, SCIENCE. 4/8

Chemist, Ph.D. 1955. Biophysical. Experienced, radioisotopes, blood chemistry, kinetics, publications. Prefer academic. Box 94, SCIENCE. X

Clinical Biochemist, Ph.D., director hospital laboratory eight years, blood grouping specialist, administration, publications. Box 88, SCIENCE. 4/1, 8, 15

Literature Scientist, Ph.D. microbiology, biochemistry, medical, industrial. Bibliographies, abstracts, reports. Box 92, SCIENCE. X

Microbiologist, M.S., woman; virology, medical bacteriology, physiology, cytology, histology, genetics, biochemistry, teaching experience. Desires academic (teaching or research); public health or hospital research. Box 106, SCIENCE. X

Organic Chemist, Ph.D.; strong background in biochemistry. Currently supervising research program for recognized chemical company. Desires academic or institutional position in fundamental research program in plant biochemistry. Interested in trace metal metabolism and protein synthesis. Industrial experience includes agricultural chemicals. Box 105, SCIENCE. 4/8

(a) Parasitologist; Sc.D., Johns Hopkins, three years, head science department, small college; five years, professor and chairman of department of biology, state university. **(b) Pharmaceutical chemist;** Ph.D.; four years, industrial research (synthesis of drugs); four years, director research, large company. Medical Bureau, (Burneice Larson, Director), Palmolive Building, Chicago. X

Parasitologist, masters degree desires position in research, public health, hospital or teaching. 5 years experience in parasitology and bacteriology. Box 67, SCIENCE. 3/18, 25; 4/1

Physiologist; Ph.D. Assistant Professor at medium sized college desires teaching or research position in west. Experienced in fatty acid research, proteolytic enzymes, cell physiology and biochemistry references and teaching experience; available in July; can be interviewed at the San Francisco Meetings. Box 103, SCIENCE. X

Zoologist, Ph.D. 3 years experience research, endocrinology, radiobiology, some teaching experience. Desire academic position, prefer East. Box 100, SCIENCE. X

Zoologist; Ph.D.; teaching research experience: immunology, genetics anatomy, physiology, biochemistry; desires academic position September 1955; Attending Federation Meetings. Box 95, SCIENCE. X

POSITIONS WANTED

Zoologist (Parasitologist, Protozoology) Ph.D. Several years teaching and research work experience, publications, references. Interested straight or industry research or teaching or teaching with research or bibliographic searcher (knowledge of several languages). Box 98, SCIENCE. X

Zoologist; Ph.D., desires academic or research position; Western U. S. or Canada; experienced in comparative physiology, histology and enzyme histochemistry; available in June, references and teaching experience. Box 102, SCIENCE. X

Zoologist, Ph.D., 29, diversified background, publications, wants teaching, research position. Interested ecology, fisheries, wildlife, proficient in all biology. Box 91, SCIENCE. X

POSITIONS OPEN

Bacteriologist to head Chemotherapeutic Department of 20 in well-known eastern pharmaceutical company. At least 10 years of post-doctoral experience required with some knowledge of parasitology and virology. Employees know of this ad. Box 99, SCIENCE. 4/1, 8, 15, 22, 29

Biochemist (Literature) M.S. in biochemistry with minor in organic chemistry to assist senior scientists in evaluation of scientific data. Research and Development Division of major Pharmaceutical Manufacturer offers advancement opportunities and liberal benefits. Outline complete education and experience. Box 96, SCIENCE. X

Biologist—with Ph.D. or M.S. for teaching undergraduate courses in zoology beginning September, 1955. Opportunities for research, especially in EEG. Apply to Director, Albers Biological Laboratory, Xavier University, Cincinnati 7, Ohio. X

Graduate Assistantships in teaching and research available for September, 1955. Load 12 or 6 hours per week. Remainder of time available for graduate work leading to Master's degree. Stipends range from $550.00 to $1900.00. **Teaching fellowships** for advanced graduate students. Load 15 hours. Stipends, $1800.00. Chemistry Department, Howard University, Washington 1, D. C. 4/1

(a) Microbiologist; experienced in virus assays with mice, egg embryos and tissue cultures; MS preferred; noted pharmaceutical house. **(b) Biochemist;** prefer experienced in radioactive substance; supervise medico-chemical lab of large teaching hospital; university city; East. **(c) Bacteriologist;** excellent opportunity in advanced virus research lab; university medical center; Midwest. **(d) Biochemist;** Ph.D. or equivalent training; excellent teaching and research opportunity; 450 bed general hospital; Mideast. **(e) Organic Chemist;** Ph.D.; operate research section and initiate new research, New England. Woodward Medical Personnel Bureau, 185 N. Wabash, Chicago. X

(a) Immuno-chemist and protein chemist; medical school research department; straight research; West. **(b) Physician** with sufficient fluency in German as to be able to translate scientific papers; pharmaceutical company; duties principally establishing clinical investigations and attending all correspondence on new products; East. **(c) Bacteriologist,** Ph.D., with training in virology; research department, 400-bed hospital; university city, Midwest. **(d) Instructor** in physics; university appointment, South. S4-1 Medical Bureau, (Burneice Larson, Director), Palmolive Building, Chicago. X

Physiology—Ph.D. in physiology with special interest and experience in neurophysiology wanted for pharmaceutical research program team work in evaluation of scientific data. Send complete record of education and experience. Box 89, SCIENCE. 4/1

Senior Research Biochemist—Ph.D. in biochemistry or physiological chemistry including broad background in basic medical sciences for east-coast Pharmaceutical Manufacturing Firm. Industrial experience helpful. Opportunity for eventual administrative duties. Send complete personal information. Box 86, SCIENCE. 4/1, 8, 15

Teaching and Research Assistantships available graduate work applied toward M.A. or Ph.D. in anatomy. Write Paul G. Roofe, Department of Anatomy, University of Kansas, Lawrence, Kansas. 3/25; 4/1

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

CLASSIFIED: 25¢ per word, minimum charge $6.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	$19.50 per inch
7 times in 1 year	17.50 per inch
13 times in 1 year	16.00 per inch
26 times in 1 year	14.00 per inch
52 times in 1 year	12.50 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

BOOKS AND MAGAZINES

WANTED TO PURCHASE . . . **SCIENTIFIC** PERIODICALS and BOOKS — Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted

WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

"Mosquito Culture Techniques and Experimental Procedures" by Helen Louise Trembley. Bulletin No. 3 of the American Mosquito Control Association. 73 pages; profusely illustrated. $2.00. Order from C. T. Williamson, 16 Orowoc Avenue, Islip, New York. 4/8

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

BACK NUMBER PERIODICALS—— Bought and Sold

• Tell us what you want?—What have you to offer?

Abrahams Magazine Service Established 1889 ▶ DEPT. P, 56 E. 13th ST. NEW YORK 3, N. Y.

BOOKS FOR SALE:

Brown, V. E. "Synopsis of Medical Parasitology"—1954 $3.75. Reviews:—Jour. A.M.A. Vol. 153, No. 17, Jan. 26, 1954; La Reforma Med., Milan, No. 31, p. 854. Bull. Pan. Amer. Sanitary Bur. W.H.O. Jan. 1954, p. 115. Archivos Medicos Cuba p. 154, 1954; Med. Jour. West Indies, 1954.

Brown, V. E. "Synopsis of Medical Entomology"—$4.50; Reviews:—Acta Med. Scand. vol. 148, p. 493; Rivista di Parasit. vol. XV, No. 3, Rome; Medical Jour. of West Indies, 1954.

order from: Dr. V. E. Brown
V. A. Hospital, Dublin, Georgia

The Author is available for teaching or research.

WANTED: BOOK MANUSCRIPTS

A publisher with high standards will be happy to read your manuscript on any subject, scientific or general. Intelligent editing, emphasis on book sales, a fair, honest cooperative contract if your work is acceptable. Write, or mail your manuscript directly, without obligation.

GREENWICH BOOK PUBLISHERS, INC.
Atten. MR. INMAN 489 FIFTH AVE.
NEW YORK 17, N. Y.

APRIL 15.
SPRING BOOK ISSUE
Send your copy in, now!

PROFESSIONAL SERVICES

BOOK MANUSCRIPTS INVITED

Write for Free Booklet SC telling how we can publish your book. All subjects considered. New authors welcome.

VANTAGE PRESS, Inc. • 120 W. 31 St., New York 1
In Calif.: 6253 Hollywood Blvd., Hollywood 28

LaWall & Harrisson
Div. S, 1921 Walnut St., Philadelphia 3, Pa.

Food & Drug PROBLEMS
PHARMACOLOGICAL · BACTERIOLOGICAL · CHEMICAL

SUPPLIES AND EQUIPMENT

German Cameras. Import your own. Save retailers, Importers profits. Example: Exakta, automatic Westanar F2.8 lens $139.00 (pay postman $19.00 duty). We pay parcel post, insurance, and all other charges. Similar prices on all famous makes. New 1955 production. Payment through bank and inspection method guarantees full protection and satisfaction. Price lists, (please outline your interests for our technical advisory service) and details airmailed immediately. Worldpost, Tangier, Morocco. 3/18, 25; 4/1

technicon
offers precision equipment for the histology and chemical laboratory.
215 East 149th Street • New York 51, N.Y.

STAINS
STARKMAN Biological Laboratory
• RARE
• COMMON
Price list on Request
461 Bloor St., W.
• Toronto, Canada

CONSISTENT RATS & MICE

All animals antibiotic free

BUDD MT. RODENT FARM
CHESTER, N. J.

Breeders of a recognized strain of Wistar rats and W. S. mice

PARASITOLOGICAL PREPARATIONS

• high quality — low priced. *Write for catalog*

TROPICAL BIOLOGICALS • P.O. Box 2227, San Juan, Puerto Rico.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

SUPPLIES AND EQUIPMENT

Cooke

INTERFEROMETER MICROSCOPE

after DYSON

- Complete contrast control on unstained specimens.
- Quantitative path difference measurements.
- No halo.

Ask for bulletin 7-15

LOVINS ENGINEERING COMPANY

P. O. Box 429 — Silver Spring, Md.

"EXPERT REPAIRS"

of

POLARIMETERS of any MAKE

Complete Reconditioning
Adjustment of Optical System

O. C. RUDOLPH & SONS

Manufacturers of Optical Research & Control Instruments

P.O. BOX 446 — CALDWELL, N. J.

ALBINO RATS*

"From the hand of the veterinarian to research"

HYPOPHYSECTOMIZED RATS

**Descendants of the Sprague-Dawley and Wistar Strains*

HENRY L. FOSTER, D.V.M.
President and Director

THE CHARLES RIVER BREEDING LABS.

Wilmington, Mass.

Biological Laboratory wishes to purchase immediately two Emerson Model A micromanipulators, new or used. Box 97, SCIENCE. X

FREE GBI CATALOG

Write for your copy of the new 1955 edition for reference use. It lists many ready-to-use, prepared test diets and media to save you time and tedious work.

GENERAL BIOCHEMICALS, INC.

73 Laboratory Park — Chagrin Falls, Ohio

SUPPLIES AND EQUIPMENT

BEAGLES

We breed exclusively pure bred beagles for research laboratories. Pups are shipped from three to nine months old. Only $50.00 each at six months. Guaranteed healthy.

Each pup is tattooed. We supply individual records of vaccination, worming and routine treatment to prevent skin and parasitic afflications. Weight-growth charts also available.

We are sold out for six months. We will gladly schedule for later delivery on a yearly agreement basis or possibly individual shipments for special studies.

Write for Complete Information.

ARCHBALD ASSOCIATES

P. O. Box 152 — East Aurora, N. Y.

UREA

and other tagged compounds
OF HIGH RADIOPURITY

ISOTOPES SPECIALTIES COMPANY INC. 3816-A San Fernando Rd. Glendale 4, Calif.

ALBINO RATS

Our mass production methods insure greatest uniformity and consistency

Price list on request

DAN ROLFSMEYER CO. ■ Phone 6-6149

Route 3, Syene Road, Madison, Wisconsin

Dajac

LABORATORIES

Leominster, Mass.

REAGENT ORGANICS

2,4,7-Trinitrofluorenone, 1,1'-Dianthrimide,2,3,5-Triphenyltetrazolium Chloride, Blue Tetrazolium, 2-Hydroxy-3-naphthoic Acid Hydrazide, N-Bromomethyl-phthalimide. **Write for catalog and descriptive literature.**

SPRAGUE - DAWLEY, INC.

PIONEERS IN THE DEVELOPMENT OF THE STANDARD LABORATORY RAT.

All shipments made from our new modern, quarantined colony.

SPRAGUE-DAWLEY, INC. - P. O. BOX 2071

Phone CEdar 3-5318 — Madison, Wisconsin